Water Resources Survey

Part I
HISTORY OF LAND AND WATER
USE ON IRRIGATED AREAS

and

Part II
MAPS SHOWING IRRIGATED AREAS
IN COLORS DESIGNATING THE
SOURCES OF SUPPLY

Liberty and Toole Counties, Montana

MONTANA STATE ENGINEER
1939

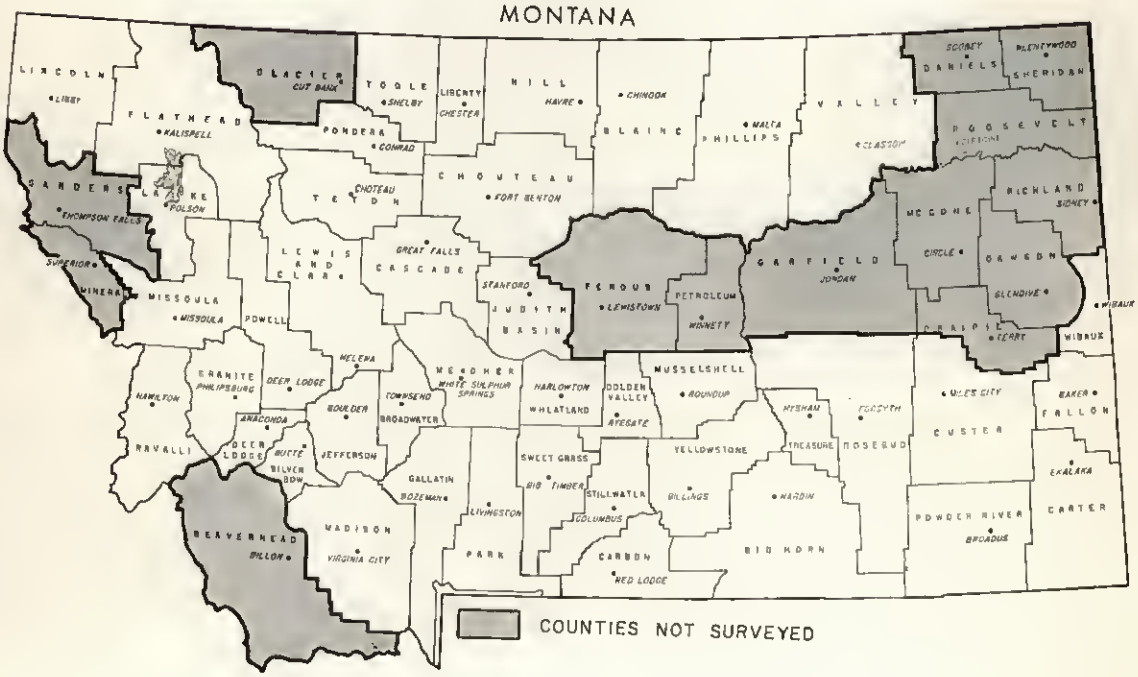
WATER RESOURCES SURVEY

LIBERTY AND TOOLE COUNTIES MONTANA

Part I

History of Land and Water Use

an Irrigated Areas



Published by
MONTANA WATER RESOURCES BOARD
Helena, Montana
June, 1969

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June, 1969

Honorable Forrest H. Anderson
Governor of Montana
Capitol Building
Helena, Montana

Dear Governor Anderson:

Submitted herewith is a consolidated report on a survey of Water Resources for Liberty and Toole Counties, Montana.

The report is divided into two parts: Part I consists of history of land and water use, irrigated lands, water rights, etc., and Part II contains the township maps in the County showing in colors the lands irrigated from each source or canal system.

Surveys have been made in the counties of Big Horn, Blaine, Broadwater, Carbon, Carter, Cascade, Chouteau, Custer, Deer Lodge, Fallon, Flathead, Gallatin, Golden Valley, Granite, Hill, Jefferson, Judith Basin, Lake, Lewis and Clark, **Liberty**, Lincoln, Madison, Meagher, Missoula, Musselshell, Park, Phillips, Pondera, Powder River, Powell, Ravalli, Rosebud, Silver Bow, Stillwater, Sweet Grass, Teton, **Toole**, Treasure, Valley, Wibaux, Wheatland, and Yellowstone. Reports are available for all of the counties except a few of the ones which were surveyed a number of years ago and these are now out of print. However, reports will again be published on these counties sometime in the future after they have been updated.

The office files contain minute descriptions and details of each individual water right and land use, which are too voluminous to be included herein. These office files are available for inspection to those who are interested.

The historical data on water rights contained in these reports can never become obsolete. If new information is added from time to time as new developments occur, the records can always be kept current and up-to-date.

Respectfully submitted,
E. V. DARLINTON, Director
Montana Water Resources Board

ACKNOWLEDGMENTS

A survey and study of water resources involves many phases of both field and office work in order to gather the necessary data to make the information complete and comprehensive. Appreciation of the splendid cooperation of various agencies and individuals who gave their time and assistance in aiding us in gathering the data for the preparation of this report is hereby acknowledged.

LIBERTY COUNTY OFFICIALS

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Arlo Graham, Commissioner — M. Sterling Wardell, Commissioner

Mrs. Aileen Greiner, Clerk and Recorder

Darby O'Brien, Clerk of District Court — Mrs. Edris Jensen, Assessor

TOOLE COUNTY OFFICIALS

H. E. Benjamin, Jr., Commissioner

Alton Wigen, Commissioner — Robert Tomsheck, Commissioner

Mrs. Jeannette E. McDonald, Clerk and Recorder

Mrs. Vivian S. Hall, Clerk of District Court — Mrs. Phyllis Dumon, Assessor

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FOREWORD

SURFACE WATER

Our concern over surface water rights in Montana is nearly a century old. When the first Territorial Legislature, meeting in Bannack, adopted the common law of England on January 11, 1865, the Territory's legal profession assumed that it had adopted the Doctrine of Riparian Rights. This doctrine had evolved in England and in the eastern United States where the annual rainfall is generally more than twenty inches. It gave the owners of land bordering a stream the right to have that stream flow past their land undiminished in quantity and unaltered in quality and to use it for household and livestock purposes. The law restricted the use of water to riparian owners and forbade them to reduce appreciably the stream flow, but the early miners and ranchers in Montana favored the Doctrine of Prior Appropriation which permitted diversion and diminution of the streams. Consequently, the next day the legislature enacted another law which permitted diversion by both riparian and non-riparian owners. Whether or not this action provided Montana with one or two definitions of water rights was not settled until 1921 when the Montana Supreme Court in the Mattler vs. Ames Realty case declared the Doctrine of Prior Appropriation to be the valid Montana water right law. "Our conclusion," it said, "is that the common law doctrine of riparian rights has never prevailed in Montana since the enactment of the Bannack Statutes in 1865 and that it is unsuited to the conditions here . . ."

The appropriation right which originated in California was used by the forty-niners to divert water from the streams to placer mine gold. They applied to the water the same rules that they applied to their mining claims—first in time, first in right and limitation of the right by beneficial use. Those who came to Montana gulches brought with them these rules, applying them to agriculture as well as to mining.

The main points of consideration under the Doctrine of Prior Appropriation are:

1. The use of water may be acquired by both riparian and non-riparian landowners.

2. It allows diversion of water regardless of the reduction of the water supply in the stream.

3. The value of the right is determined by the priority of the appropriation; i.e., first in time is first in right.

4. The right is limited to the use of the water. Stream waters in Montana are the property of the State and the appropriator acquires only a right to their use. Moreover, this use must be beneficial.

5. A right to the use of water is considered property only in the sense that it can be bought or sold; its owner may not be deprived of it except by due process of law.

The State Legislature has provided methods for the acquisition, determination of priority and administration of the right. No right may be acquired on a stream without diversion of water and its application to a beneficial use. On unadjudicated streams, the Statutes stipulate that the diversion must be preceded by posting a notice at a point of intended diversion and by filing a copy of it within 20 days in the county clerk's office of the county in which the appropriation is being made.

Construction of the means of diversion must begin within 40 days of the posting and continue with reasonable diligence to completion. However, the Montana Supreme Court has ruled that an appropriator who fails to comply with the Statutes may still acquire a right merely by digging a ditch and putting the water to beneficial use.

To obtain a water right on an adjudicated stream one must petition the District Court having jurisdiction over the stream for permission to make an appropriation. If the other appropriators do not object, the court gives its consent and issues a supplementary decree granting the right subject to the rights of the prior appropriators.

Montana laws do not require water users to file official records of the completion of their appropriations; therefore, it becomes advisable as soon as the demand for the waters of a stream becomes greater than its supply, to determine the rights and priorities of each user by means of an adjudication or water right suit. This action may be initiated by one or more of the appropriators who make all the other claimants parties to the suit. The Judge of the District Court then examines all of the claims and issues a decree establishing priority of the right of each water user and the amount of water he is entitled to use. The court decree becomes in effect the deed of the appropriator to his water right.

Whenever scarcity of water in an adjudicated stream requires an allocation of the supply according to the priority of rights, the Judge, upon petition of the owners of at least 15 percent of the water rights affected, must appoint a water commissioner to distribute the water. Chapter No. 231, Montana Session Laws 1963, Senate Bill 55 amended Section 89-1001 R.C.M. 1947, to provide that a water commissioner be appointed to distribute decreed water rights by application of fifteen percent (15%) of the owners of the water rights affected, or, under certain circumstances at the discretion of the Judge of the District Court—**"provided that when petitioners make proper showing they are not able to obtain the application of the owners of at least fifteen percent (15%) of the water rights affected, and they are unable to obtain the water to which they are entitled, the Judge of the District Court having jurisdiction may, in his discretion, appoint a water commissioner."** After the Commissioner has been appointed the Judge gives his instructions on how the water is to be apportioned and distributed in accordance with the full terms of the decree.

The recording of appropriations in local courthouses provides an incomplete record of the water rights on unadjudicated streams. In fact, the county records often bear little relation to the existing situation. Since the law places no restriction on the number or extent of the filings which may be made on an unadjudicated stream, the total amount of water claimed is frequently many times the available flow. There are numerous examples of streams becoming over appropriated. Once six appropriators each claimed all the water in Lyman Creek near Bozeman. Before the adjudication of claims to the waters of Prickly Pear Creek, 68 parties claimed thirty times its average flow of about 50 cfs. Today, the Big Hole River with an average flow of about 1,000 cfs. has filings totaling 173,912 cfs. One is unable to distinguish in the county courthouses the perfected rights from the unperfected ones since the law requires no official recording of the completion of an appropriation. Recognition by the courts of unrecorded appropriations adds to the incompleteness of these records. To further complicate the situation, appropriators have used different names for the same stream in their filings. In Montana, many of the streams are found distributed in two or more county courthouses. Anyone desirous of determining appropriations on a certain river or creek finds it difficult and expensive to examine records in several places. In addition, the records are sometimes scattered because the original nine counties of 1865 have now increased to 56. As the orig-

inal counties have been divided and subdivided, the water right filings have frequently not been transcribed from the records of one county to the other. Thus, a record of an early appropriation to what is at present Powell County may be found in the courthouse of the original Deer Lodge County.

It can readily be seen that this system of recording offers little protection to rights in the use of water until they are determined by adjudication. In other words, an appropriator does not gain clear title to his water right until after adjudication, and then the title may not be clear because the Montana system of determining rights is also faulty. In the first place, adjudications are costly, sometimes extremely costly when they are prolonged for years. It is estimated that litigation over the Beaverhead River, which has lasted more than twenty years, has cost the residents of the valley nearly one-half million dollars. In the second place, unless the court seeks the advice of a competent irrigation engineer, the adjudication may be based upon inaccurate evidence; in the third place, if some claimant has been inadvertently left out of the action, the decree is not final and may be reopened for consideration by the aggrieved party. Another difficulty arises in determining the ownership of a water right when land under an adjudicated stream becomes subdivided in later years and the water is not apportioned to the land by deed or otherwise. There is no provision made by law requiring the recording of specific water right ownership on deeds and abstracts.

The Legislative Session of 1957 passed Chapter 114 providing for the policing of water released from storage to be transmitted through a natural stream bed to the place of use. The owner of the storage must petition the court for the right to have the water policed from the storage reservoir to his place of use. If there are no objections the court may issue the right and appoint a water commissioner to distribute the water in accordance therewith. This law applies only to unadjudicated streams.

Administration of water on adjudicated streams is done by the District Court, but it has its drawbacks. The appointment of a water commissioner is often delayed until the shortage of water is acute and the court frequently finds it difficult to obtain a competent appointee for so temporary a position. The present administration of adjudicated streams which cross the county boundaries of judicial districts creates problems. Many of the water decrees stipulate head gates and measuring devices for proper water distribution, but in many instances the stipulation is not enforced, causing disagreement among water users.

Since a water right is considered property and may be bought and sold, the nature of water requires certain limitations in its use. One of the major difficulties encountered after an adjudication of a stream is the failure of the District Court to have control over the transfer of water rights from their designated places of use. The sale and leasing of water is becoming a common practice on many adjudicated streams and has created serious complications. By changing the water use to a different location, many of the remaining rights along the stream are disrupted, resulting in a complete breakdown of the purpose intended by the adjudication. Legal action necessary to correct this situation must be initiated by the injured parties as it is their responsibility and not that of the court.

At one time or another all of the Western Reclamation States have used similar methods of local regulation of water rights. Now all of them, except Montana, have more or less abandoned these practices and replaced them by a system of centralized state control such as the one adopted by the State of Wyoming. The key characteristics of the Wyoming system are the registration of both the initiation and completion of an appropriation in the State Engineer's Office, the determination

of rights and administration by a State Board of Control headed by the State Engineer. These methods give the Wyoming water users title to the use of water as definite and defensible as those which they have to their land.

When Montana began to negotiate the Yellowstone River Compact with Wyoming and North Dakota in 1939, the need for some definite information concerning our water and its use became apparent. The Legislature in 1939 passed a bill (Ch. 185) authorizing the collection of data pertaining to our uses of water and it is under this authority that the Water Resources Survey is being carried on. The purpose of this survey is: (1) to catalogue by counties in the office of the State Engineer, all recorded, appropriated, and decreed water rights including the use rights as they are found; (2) to map the lands upon which the water is being used; (3) to provide the public with pertinent water right information on any stream, thereby assisting in any transaction involving water; (4) to help State and Federal agencies in pertinent matters; (5) to eliminate unnecessary court action in water right disputes; and (6) to have a complete inventory of our perfected water rights in case of need to defend these rights against the encroachments of lower states, or Wyoming or Canada.

GROUND WATER

Ground water and surface water are often intimately related. In fact, it is difficult in some cases to consider one without the other. In times of heavy precipitation and surface runoff, water seeps below the land surface to recharge underground reservoirs which, in turn, discharge ground water to streams and maintains their flow during dry periods. The amount of water stored underground is far greater than the amount of surface water in Montana, and, without seepage from underground sources it is probable that nearly all the streams in the state would cease to flow during dry periods.

It is believed that Montana's ground water resources are vast and only partly developed. Yet, this resource is now undergoing accelerated development as the need for its use increases and economical energy for pumping becomes available. Continued rapid development without some regulation of its use would cause a depletion of ground water in areas where the recharge is less than the withdrawal. Experience in other states has shown that once excessive use of ground water in a specific area has started, it is nearly impossible to stop, and may result in painful economic readjustments for the inhabitants of the affected area.

Practical steps aimed at conserving ground water resources as well as correcting related deficiencies in surface water laws became necessary in Montana. Prior to the Legislative Session of 1961, there was no legal method of appropriating ground water. Proposed ground water codes were introduced and rejected in four biennial sessions of the Montana Legislative Assembly — 1951, 1953, 1955, and 1959.

In 1961, during the 37th Legislative Session, a bill was introduced and passed creating a Ground Water Code in Montana (Chapter 237, Revised Codes of Montana, 1961). This bill became effective as a law on January 1, 1962, with the State Engineer of Montana designated as "Administrator" to carry out provisions of the Act. However, the 1965 Legislature abolished the office of the State Engineer and transferred his duties to the State Water Conservation Board, effective July 1, 1965. On July 1, 1967, the name of the State Water Conservation Board was changed to the Montana Water Resources Board. Therefore, the Montana Water Resources Board became the "Administrator" of this Act.

Some of the important provisions contained in Montana's Ground Water Law are:

Section 1. **Definitions or Regulations as Used in the Act.**

(a) "Ground Water" means any fresh water under the surface of the land including the water under the bed of any stream, lake, reservoir, or other body of surface water. Fresh water shall be deemed to be the water fit for domestic, livestock, or agricultural use. The Administrator, after a notice nf hearing, is authorized to fix definite standards for determining fresh water in any controlled ground water area or sub-area of the State.

(b) "Aquifer" means any underground geological structure or formation which is capable of yielding water or is capable of recharge.

(c) "Well" means any artificial opening or excavation in the ground, however made, by which ground water can be obtained or through which it flows under natural pressures or is artificially withdrawn.

(d) "Beneficial use" means any economically or socially justifiable withdrawal or utilizations of water.

(e) "Person" means any natural person, association, partnership, corporation, municipality, irrigation district, the State of Montana, or any political sub-division or agency thereof, and the United States or any agency thereof.

(f) "Administrator" means the Montana Water Resources Board of the State of Montana.

(g) "Ground Water Area" means an area which, as nearly as known facts permit, may be designated so as to enclose a single distinct body of ground water, which shall be described horizontally by surface description in all cases and which may be limited vertically by describing known geological formations, shnuld conditions dictate this to be desirable. For purpose of administration, large ground water areas may be divided into convenient administrative units known as "sub-areas."

Section 2. **Right to Use.**

Rights to surface water where the date of appropriation precedes January 1, 1962, shall take priority over all prior or subsequent ground water rights. The application of ground water to a beneficial use prior to January 1, 1962, is hereby recognized as a water right. Beneficial use shall be the extent and limit of the appropriative right. As to appropriations of ground water completed on and after January 1, 1962, any and all rights must be based upon the filing provisions hereinafter set forth, and as between all appropriators of surface or ground water on and after January 1, 1962, the first in time is first in right.

Any ground water put to beneficial use **after** January 1, 1962, **must** be filed with the County Clerk and Recorder in the county where the ground water is withdrawn in order to establish a right to use of the water.

Montana's Ground Water Code now provides for three different types of forms available for filing water rights depending upon the nature of the ground water development. The old Form No. 4 became invalid after January 1, 1966.

Form No. 1 **"Notice of Appropriation of Ground Water"**—shall require answers to such questions as (1) the name and address of the appropriator; (2) the beneficial use for which the appropriation is made, including a description of the lands to be benefited if for irrigation; (3) the rate of use in gallons per minute of ground water claimed; (4) the annual period (inclusive dates) of intended use; (5) the probable or intended date of first beneficial use; (6) the probable or intended date of commencement and completion of the well or wells; (7) the location, type, size, and depth of the well or wells contemplated; (8) the probable or estimated depth of the water table or artesian aquifer; (9) the name, address, and license number of the driller engaged; and (10) such other similar information as may be useful in carrying out the policy of this Act. This form is optional but it has an advantage in that after filing the Notice of Appropriation, a person has 90 days in which to commence actual excavation and diligently prosecute construction of the well. Otherwise, failure to file the Notice of Appropriation deprives the appropriator of his right to relate the date of the appropriation back upon filing the Notice of Completion. (Form No. 2.)

Form No. 2 **"Notice of Completion of Ground Water by Means of Well"**—this form shall require answers to the same sort of questions as required by Form No. 1 (Notice of Appropriation of Ground Water), except that for the most part it shall inquire into accomplished facts concerning the well or means of withdrawal, including (a) information as to the static level of water in the casing or the shut-in pressure if the well flows naturally; (b) the capacity of the well in gallons per minute by pumping or natural flow; (c) the approximate drawdown or pumping level of the well; (d) the approximate surface elevation at the well head; (e) the casing record of the well; (f) the drilling log showing the character and thickness of all formations penetrated; (g) the depth to which the well is drilled; and similar information.

It shall be the responsibility of the driller of each well to fill out the Form No. 2, "Notice of Completion of Ground Water by Means of a Well," for the appropriator, and the latter shall be responsible for its filing.

Form No. 3 **"Notice of Completion of Ground Water Appropriation Without a Well"**—is for the benefit of persons obtaining (or desiring to obtain) ground water without a well, such as by sub-irrigation or other natural processes so as to enable such persons to describe the means of using ground water; to estimate the amount of water so used; and requiring such other information pertinent to this particular type of ground water use.

Montana's Ground Water Code, as amended by the 1965 Legislature, provides for a period of four (4) years after January 1, 1962, for filing on vested ground water rights (all ground water used prior to January 1, 1962, from water wells, developed springs, drain ditches, sub-irrigation, etc.). Therefore, the deadline was December 31, 1965. A person did not lose his vested ground water rights by failure to file within the four-year period although, in the event of a future ground water dispute, he may be called upon to prove his rights in court. If a person files now on ground water developed prior to January 1, 1962, his date of priority becomes the date of filing, rather than the date when the water was first used.

It shall be recognized that all persons who have filed a Water Well Log Form as provided for under Section 1 and 2 of Chapter 58, Session Laws of Montana, 1957, shall be considered as having complied with the requirements of this Act.

It is important to note that ground water law states, **"Until a Notice of Completion (form #2 or #3) is filed with respect to ANY use of ground water instituted AFTER January 1, 1962, NO right to that use of water shall be recognized."**

Copies of the forms used in filing on ground water are available in the County Clerk and Recorder's Office in each of Montana's 56 counties. It shall be the duty of the County Clerk in every instance to file the original copy of the county records; transmit the second copy to the Administrator (Montana Water Resources Board); and the third copy to the Montana Bureau of Mines and Geology; and the fourth copy to be retained by the appropriator (person making the filing).

Accurate records and the amount of water available for future use are essential in the administration and investigation of water resources. In areas where the water supply becomes critical, the ground water law provides that the administrator may define the boundaries of the aquifer and employ inspectors to enforce rules and regulations regarding withdrawals for the purpose of safeguarding the water supply and the appropriators (see wording of the law for establishing a "controlled area").

The filing of water right records in a central office under control of a responsible State agency, provides the only efficient means for the orderly development and preservation of our water supplies and it protects all of Montana's use—on both ground and surface water.

METHOD OF SURVEY

Water resources data contained in Part I and Part II of this report are obtained from courthouse records in conjunction with individual contacts with landowners. A survey of this type involves extensive detailed work in both the office and field to compile a comprehensive inventory of water rights as they apply to land and other uses.

The material of foremost importance used in conducting the survey is taken from the files of the county courthouse and the data required includes: landownership, water right records (decrees and appropriations), articles of incorporation of ditch companies and any other legal papers concerning the distribution and use of water. Deed records of landownership are reviewed and abstracts are checked for water right information when available.

Aerial photography is used by the survey to assure accuracy in mapping the land areas of water use and all the other detailed information which appears on the final colored township maps in Part II. Section and township locations are determined by the photogrammetric system, based on government land office survey plats, plane-table surveys, county maps and by "on-the-spot" location during the field survey. Noted on the photographs are the locations of each irrigation system, with the irrigated and irrigable land areas defined. All the information compiled on the aerial photo is transferred and drawn onto a final base map by means of aerial projection. From the base map, color separation maps are made and may include three to ten overlay separation plates, depending on the number of irrigation systems within the township.

Field forms are prepared for each land owner showing the name of the owner and operator, photo index number, a plat defining the ownership boundary, type of irrigation system, source of water supply and the total acreage irrigated and irrigable under each. All of the appropriated and

decreed water rights that apply to each ownership are listed on the field forms with the description of intended place of use. During the field survey, all water rights listed on the field form are verified with the landowner. Whenever any doubt or complication exists in the use of a water right, deed records of the land are checked to determine the absolute right and use.

So far as known, this is the first survey of its kind ever attempted in the United States. The value of the work has become well substantiated in the counties completed to date by giving Montana its first accurate and verified information concerning its water rights and their use. New development of land for irrigation purposes by State and Federal agencies is not within the scope of this report. The facts presented are found at the time of completion of each survey and provide the items and figures from which a detailed analysis of water and land use can be made.

The historical data contained in these reports can never become obsolete. If new information is added from time to time as new developments occur, the records can always be kept current and up-to-date.

Complete data obtained from this survey cannot be included in this report as it would make the text too voluminous. However, if one should desire detailed information about any particular water right, lands irrigated, or the number and amount of water rights diverting from any particular stream, such information may be obtained by writing the Montana Water Resources Board in Helena.

Every effort is being made to insure accuracy of the data collected rather than to speed up the work which might invite errors.

WATER RESOURCES SURVEY

Liberty County, Montana

PART I

History of Land and Water Use on Irrigated Areas

Published by
MONTANA WATER RESOURCES BOARD
Helena, Montana
June, 1969

HISTORY AND ORGANIZATION

The first recorded visit of white men into the area now included within the boundaries of Liberty County was that of Captain Lewis and party who traveled north from the great falls of the Missouri River in July, 1806, their objective being the Marias River, discovered and named by the explorer a year before.

After the Lewis & Clark Expedition came the fur traders and other iron-nerved adventurers who further exploited the amicable relations with the Indians begun by the explorers, Lewis & Clark. These men were more numerous, perhaps, along the Marias River where trade developed more rapidly than in other sections of Montana because of the acceptance of the white men by the Indians. But this "better" relationship was comparative only, and did not apply to each individual Indian or to individual groups. Hair raising adventures, not all figurative, were frequent; and many traders found their way to the pearly gates along this river, named, as it has been said, for the girl of Lewis' dreams.

With the close of the fur trade era, the country reverted to the Indians. If Captain Lewis could have returned 75 years later he would have found the country little changed.

In 1874, when the international boundary survey was being made, some prospecting was carried on in the Sweet Grass Hills for a short period of time. Some ten years later the interest in mining was revived for a short time, then it again subsided. Incorporation of all the territory north of the Marias River in an Indian Reserve effectually barred the district from progressive whites with the result, that so far as development was concerned, the Liberty County area remained dormant for a number of years.

It was along in the late 1880's when the reserve was finally opened, that actual development began with stock outfits moving in along the Marias on Cottonwood Creek and on the streams of the Sweet Crass Hills. This area, which is now Liberty County was ideal stock country—one big plush pasture—that was held by stockmen for 30 years, before an occasional homesteader's shack heralded the dawn of a new era and the passing of the open range.

Agriculture is the principal industry in Liberty County with over 90 percent of its land area active in grain and cattle production. Some of the highest protein spring and winter wheat is grown in the county and grain buyers have paid up to 75¢ per bushel over and above the market price for this high quality grain. In addition to wheat, some of the highest quality feed and malting barley is grown here. Most of the farms grow dryland grains with the average farm containing 2,842 acres. Strip and contour farming practices are utilized by the progressive farmers in Liberty County.

Since the discovery of natural gas in the Whitlash Field in 1918, the total value of oil and gas produced in Liberty County up to December 31, 1967, is in excess of sixteen million dollars.

The two most important fields are Flat Coulee and Whitlash, and others are Bear's Den, Keith, Grandview and Utopia. Further information on the petroleum industry in Liberty County appears in the Economic Mineral Resources section of this report.

The communities of Liberty County include Chester, the county seat, located 12 miles north of the Tiber Reservoir on U. S. Highway No. 2. At Chester, an all-weather airport is maintained by the county with surfaced runways that will accommodate planes of the DC-3 size fully loaded.

Other towns in the county are Joplin, located on U. S. Highway No. 2 and on the main line of the Great Northern Railway; Lothair, a small rural community, is located in the western part of the county on U. S. Highway No. 2 and the Great Northern Railway; and Whitlash in the extreme northwestern part near the Sweet Grass Hills area.

Tiber Dam constructed by the Bureau of Reclamation in 1956 provides recreation facilities and a water supply to the town of Chester, as well as a potential source of water for irrigation of lands along the Milk and Marias river drainages. Excellent fishing is found in the Tiber Reservoir and in the Marias River below the dam. Boating and camping facilities are provided for along the lake shore of the reservoir.

Means of transportation in the county consist of the main line of the Great Northern Railway and U. S. Highway No. 2, both of which run east and west across the county. Other facilities include the Intermountain Bus Lines, numerous truck lines and the county airport at Chester.

Liberty County was formed out of parts of Hill and Chouteau Counties on February 11, 1920. The county is rectangular in shape, having a width of 24 miles from east to west and a length of 60 miles from north to south. It has an area of 1,459 square miles and at the last census in 1960 supported a population of 2,624 residents. Located in the north-central part of Montana, Liberty County is bounded on the north by Canada, on the east by Hill County, on the south by Chouteau County and on the west by Toole and Pondera Counties.

CLIMATE

One of the counties adjoining the Canadian International Boundary, Liberty has a climate depending to quite a degree on topography, although neither climate nor topography vary nearly as much as in the more mountainous areas to the west. Ranging in elevation from nearly 7,000 ft. on East Butte of the Sweetgrass Hills, down to about 2,800 ft. where the Marias River flows into the southwest tip of Hill County, elevation differences are large enough to create local differences, and the data for the three climatological stations appearing on the tables should be used with that in mind. Much of the area is rolling hills, and drainage roughly is from northwest to southeast—although there are many small-area exceptions. Sage Creek and the Marias River, with their tributaries, are the primary drainages.

Roughly 100 miles east of the Continental Divide, the county is well within the east slope area affected by the locally famous "chinook" wind; otherwise the climate can safely be classed as a continental type. Cold season "chinooks," when they start to blow, usually are accompanied by rapid warming, often from near or below zero temperatures to near or above the 32° freezing point of water. This wind phenomenon may be expected to occur at the end of almost every one of the half-dozen or more cold waves which visit the area each winter, and may last for several days at a time. Cold waves themselves seldom last for more than three days before the onset of a "chinook." This wind sometimes develops considerable strength; unofficial reports over the years have indicated that gusts have approached 100 mph at times. But sustained speeds of more than 60 to 70 mph are rare.

Cold waves now (1968) do not present the problems they did a half century or more ago, with modern communications, roads, equipment, etc., helping in many ways—but to the unwary or unpre-

pared they still have dangerous potential. Storms of other types occur at times: thunder, lightning (sometimes with hail) are observed 20 to 30 days a year, mostly during the warmer months. Damaging hail occurs somewhere in the county most years, but seldom is widespread. Tornadoes have been observed, but infrequently, and those that have been seen have been quite small and caused little damage. Flooding has occurred on a few occasions over the years, most recently when the 1964 flood gave trouble on the Marias around Tiber Reservoir, and in 1967 when melting of a snow accumulation produced high water on Sage Creek and tributaries on the slopes leading from Sweetgrass Hills.

Warm and pleasant summers, with most rain coming from afternoon showers and thundershowers, give way to the alternate cool and warm spells of fall beginning about mid-September, and wintry storms may occur from mid-September until early May when the transition to summery weather is quite rapid. Most seasons have much sunny weather. Extremely hot weather is rare, and oppressive combinations of heat and humidity do not occur. Even the few quite warm (95° or warmer) days that occur cool rather quickly near sunset, only rarely failing to reach 60° or cooler by sunrise. The freeze-free season in most of the county averages about 110 days (May 28 to September 15) but may range from as little as 90 days colder seasons to as much as 150 in an exceptionally long season.

Precipitation varies somewhat across the county, with the wetter areas corresponding mostly with the higher elevations of the northern half. A large proportion of the annual moisture, 80 to 85 percent, comes during the warmer half of the year, and snowfall averages only 20 to 30 inches a year at the lower elevations, but perhaps twice that much—or more—on Sweetgrass Hills.

The attached listing of data for three county locations will be noted to represent only the south half of the county; a new station 26 miles NNW of Chester, started late in 1964, indicates that precipitation is indeed heavier in the north half, but temperature differences may be small.

PRECIPITATION

Station	Years of Record	Elevation	Yearly Average Total	Growing Season Average Total	Percent Falling in Growing Season	Wettest Year	Driest Year
Chester	1943-1967	3,140	10.05	8.00	80	13.70 (1958)	7.16 (1944)
Joplin 1 N...	1953-1967	3,360	10.91	9.03	83	14.85 (1965)	6.13 (1961)
Tiber Dam..	1953-1967	2,850	9.99	8.24	82	13.17 (1964)	7.01 (1957)

TEMPERATURE

Station	Years of Record	Elevation	Highest and Year of Record	Lowest and Year of Record	January Average	July 2 Average	Annual Average
Chester	1943-1967	3,140	105 (1961)	–57 (1950)	13.9	67.1	41.3
Joplin 1 N...	1954-1967	3,360	106 (1961)	–34 (1964)	13.9	67.5	40.9
Tiber Dam...	1953-1967	2,850	107 (1961)	–53 (1954)	16.6	69.3	44.0

POTENTIAL IRRIGATION DEVELOPMENT

Glenn R. Smith, Soil Scientist

INTRODUCTION

Many factors determine the desirability of an area for irrigation development. The major ones are soil, water, climate, and markets. The first three determine the capacity of an area to produce; all four determine the kind of **crops** that might be grown and the monetary returns that might be expected.

This article is based on a long range projection which disregards the present available water supply and market factors of irrigation development. The climate of the county is discussed in another section of this publication.

The author realizes that the presently inadequate water supply hinders any large scale irrigation in the major portion of Liberty County, however, the long time future agricultural needs may warrant delivery of water from other sources than the local natural stream flows and reservoir storage.

The purpose of the land classification studies is to outline the land areas that have a future potential for irrigated agriculture into the ultimate of year 2020. Technological advances in irrigation are considered in this report and the slope and surface topography become less important, due to the rapid expansion of sprinkler irrigation in the west.

The final test of the success of any irrigation project is the ability of the land to provide economic benefits. It follows, therefore, that land for irrigation should be selected to ensure that this objective can be achieved. The areas outlined on the map accompanying this report are only of a generalized reconnaissance type of land classification and any definite irrigation project planning should be based on a detailed study.

The term **irrigable land** is defined as lands capable of being irrigated by gravity or sprinkler methods of water application; however, the land must have soil, topography and drainage features which will withstand a sustained irrigated agriculture.

PHYSIOGRAPHIC FEATURES

Liberty County is located in the more shallow glacial drift-covered portion of the Great Plains. The greater part of the area is a high rolling plain, characterized by broad glaciated divides sloping gently to the southeast. The Sweet Grass Hills rise several thousand feet above the plains in the northwestern part and have a local influence on the drainage and climate. Ranging in elevation from nearly 7,000 feet on East Butte of the Sweet Grass Hills, down to about 2,800 feet where the Marias River flows into southwest Hill County, elevation differences are large enough to create local differences in precipitation, soils, drainage and adaptable crops.

Erosion has not greatly changed the surface features of the glacial drift-covered area since the time of glaciation, except along some of the more deeply entrenched perennial streams and on the more shallow drift-covered divides.

The glacial drift-covered plains have a rolling to billowy, hummocky topography, characterized locally by shallow lake depressions and low mounds and ridges. The deeper deposits of glacial drift

R.4E R.5E R.6E R.7E

T. 37N

T. 36N

T. 35N

T. 34N

T. 33N

T. 32N

T. 31N

T. 30N

T. 29N

T. 28N

R.3E

WHITLASH

JOPLIN

CHESTER

LOTHAIR

Bear Creek
Davis Bear Creek
Laird Coulee
Long Coulee
Lily Coulee
Stratton Gulch
Deer Coulee
Big Mac Coulee
Chicken Creek
Caal Coulee
Corvers Coulee
Simminook Coulee
Lost Creek
Laird Creek
Sage Creek
Babcock Coulee
Bell Coulee
Keller Coulee
Leach Coulee
Bear Creek
Bangore Creek
Halfbreed Coulee
North Fork Ribbon Creek
Sage Creek
North Fork Scotch Coulee
Little Tootsie Sage Creek
Little Antelope Coulee
Corral Coulee
Cottonwood Creek
McIntosh Coulee
Snooze Coulee
Desert Coulee
Cicon Coulee
Spring Coulee
Flink Coulee
Dry Coulee
Phillips Coulee
Johnston Coulee
Eagle Creek
Horse Creek
Timber Coulee
Pondero Coulee
Corlsons Coulee
Basin Coulee
Uphill Coulee
Dugout Coulee
Layton Coulee
Wolfe Coulee
Black Coulee
Reservoir
Timber
Pondero
Basin
Uphill
Dugout
Layton
Wolfe
Black
Corlsons
Pondero

POTENTIAL IRRIGATION DEVELOPMENT
LIBERTY COUNTY

Reconnaissance studies showing land generally favorable for irrigation.

NOTE: Lands are mapped regardless of available water supply.

occur on the ridges of the Sweet Grass Hills. The more stony moraine sections are found (1) on the eastern slopes of the Sweet Grass Hills, and (2) on high divides between the buttes. Very stony tracts are found locally along some preglacial stream courses and on the crest of the higher divides extending out from the Sweet Grass Hills.

The Sweet Grass Hills area is rough and broken land with only a few scattered tracts of presently irrigated and potentially irrigable land within the area.

SURFACE DRAINAGE

Glaciation did not greatly influence the drainage of Liberty County. The larger streams were dammed and their valleys partly filled with glacial drift, but when the ice receded most of the streams returned to their former courses. There is sufficient evidence to presume the presence of many miles of buried valleys and stream channels under the Marias River flood plain and elsewhere that are filled with glaciofluvial deposits. These valleys are vestiges of preglacial and glacial drainage systems. The pre-glacial drainage may aid in subdrainage of the glacial uplands by furnishing a vertical movement downward of subsurface water.

Marias River Basin

The Marias River has a generally southeasterly course through Liberty County. The river flows on a sandy-gravelly bottom averaging 60 feet wide and during low water is from 1 to 2 feet deep. The stream carries a large volume of water during the spring runoff and again in May and June when it is swollen by the seasonal rains and by melting snow on the high divides and mountains. The valley area is subject to flooding, however, the occurrence of major floods do not prevent irrigation beyond feasibility of development, there are several farmer-pumping stations for tracts of irrigated land which produce forage crops for livestock feed.

The intermittent streams, and coulees draining into the Marias River are entrenched in narrow valleys and do not add appreciable acreages to the potential irrigable land of Liberty County. The majority of the county drains into small creeks of the Marias River Basin, the network of drainages will furnish adequate outlets for necessary subsurface drains under an irrigated agriculture.

The two main drainage basins of the Marias River in Liberty County are Eagle Creek and Cottonwood Creek. Eagle Creek heads on the southeastern slope of East Butte and flows almost due south, emptying into the portion of Tiber Reservoir which was formerly the mouth of Willow Creek. Cottonwood Creek flows from the southern slope of East Butte in a slightly southeast direction and empties into the Marias River in the southeastern part of the county. The streams are enclosed in canyons and rough terrain within the mountains and foothills. The stream basins widen below the rough mountainous regions with many smaller coulees draining into the existing channels. The flows of these streams are very small, becoming nil during the dry summer months. The natural drainage ways of Eagle and Cottonwood Creeks would furnish adequate outlet systems for surface and subsurface drains of any future irrigation.

The southern portion of Liberty County drains into Pondera, Basin and Dug Out Coulees which are intermittent flows. The drainage basins have very little irrigable land and any expansion in flow is very doubtful.

Milk River Basin

The areas north and east of the Sweet Crass Hills are drained by streams entering the Milk River, which crosses the international line a short distance east of the Liberty-Hill County line. In Liberty County the larger streams of the Milk River are Sage and Half Breed Creeks. The flows of these streams are very small and at times are nil.

Sage Creek heads on the northern slopes at East Butte and flows northeast as far as the mouth of Laird Creek where it turns to the southeast and enters Hill County. Below the foothills the stream and its intermittent branches are deeply entrenched in a gently rolling shallow glacial drift-covered section. The tributaries of Sage Creek head in the Sweet Grass Hills and flow through a high hummocky ridge type terrain before meandering through the rolling glacial uplands. The valleys of these streams are narrow and of scabby soils which are non-irrigable lands. The stream valleys and small tributaries do furnish a beneficial network of natural wasteways for any future irrigation development.

Half Breed Creek is a small stream heading on the high morainic divide between East and West Butte. This stream and other smaller tributaries contribute only small acreages of valley lands to the potential irrigable area of Liberty County; any increase in flows due to future irrigation development will be nil.

SOILS

The soils of Liberty County have been developed from glacial material deposited in the district and can be divided according to the soil forming process from the material: (1) glacial soils formed as a result of ice during the glacial period, (2) alluvial soils formed by streams during ancient and recent times, (3) residual soils formed from material weathered from the geological formations.

The physiography, drainage, and geologic history influence deposition of materials and account for many differences found in soils. Soil depth, texture, and acidity or alkalinity are directly related within limits to the material from which the soil is formed.

The variations in the soils result from the alteration of geologic material, by climate and living organisms, especially plant growth. The length of time these factors have been active and the topography is particularly influential in causing visible soil differences over short distances, often within a few feet.

Glacial Soils

The major event in the geologic history that influenced the soils of Liberty County was continental glaciation. The Keewatin ice sheet which developed in central Canada during the Late Wisconsin period of Claciation spread over the greater part of southern Alberta and northern Montana, east of the main range of mountains. It covered the plains of Liberty County and extended well up the slopes of the Sweet Grass Hills. This major event influenced the soils of the northern plains, the sand, silt, clay, gravel, and boulders were picked up by the ice sheet which mixed them by crushing and then redeposited the mixture known as glacial till. This mantle varies from less than one foot to over 100 feet in thickness. Although the glacier mixed materials it had carried for long distances with materials from underlying bedrock, in the main the largest percentage of till is of local origin; this means it strongly reflects the nature of the underlying bedrock.

The till varies in permeability, depending on its chemical and physical composition. It varies in salt content, and it varies in the amount of free carbonate it contains.

Till was deposited by a pushing action, and therefore natural cleavage lines run vertically as well as horizontally. The permeability may vary considerably within short distances depending upon the number of cleavage lines and also the variability of the composition. In general, there is downward movement of excess water. This water is held at the till-bedrock contact, and if the bedrock dip is toward the natural drainage channels it eventually moves laterally and then out along the drainage channels.

The retreat of the glacial ice caused an abundance of water either in running streams or if enclosed basins existed the water formed lakes. The coarser materials, sand and gravels, usually settled out near the margins of ice; the fine materials silt, and clay, settled farther from the ice margins and were often deposited in bodies of still water such as ponds and lakes.

Most of the potential irrigable lands of Liberty County are located in the glacial uplands and ancient lake beds of the plains.

The topography of the area varies from level to hilly—much of the hilly topography occurs in the northern part of the county and near the Sweet Grass Hills. The acreages of potential irrigable land are too small for consideration in this report.

The rolling to level topography occurs in the central portion of the county and dryland wheat is being grown in the major portion of the area. Most of these areas can be divided into gently rolling topography and relatively level terrain. The topographic conditions have influenced the soils forming process.

The soils of the rolling terrain are shallower to glacial till, and have a definite high lime zone which becomes shallower on the higher ridges. The only means of irrigation would be by sprinkler, and then with limitations. The limitations being a network of tile drainage and with proper application of water being applied to ensure leaching of salts. However, the amount of water applied would have to be sufficient to prevent salt accumulation in the root zone. The ordinary sprinkler heads would have to be enlarged to increase water application. Experiments performed in Canada showed salt accumulation increasing in areas where too little amount of water is applied by sprinkling. The amount of water application is not known at this time, however, future experiments could determine the proper practices to be followed. The undulating topography covers an estimated 285,300 acres of the irrigable area of Liberty County.

A typical soil of the undulating glacial uplands is as follows:

The soils are well drained, thin solum Brown soils developed in friable loam to clay loam till. These soils when cultivated have a loam to clay loam "A" horizon which includes most of the "B" horizon, a thin prismatic lower zone, and a distinct "C" horizon with segregated lime. The weathered soil material over till varies from 28" to 48" in depth.

Typical Soil Profile

0″ - 5″	Dark grayish brown loam to clay loam, moist, strong fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; noncalcareous.
5″ - 6½″	Dark grayish brown clay loam, moist, prismatic breaking to strong fine blocky structure; hard, friable, sticky and plastic; noncalcareous.
6½″ - 9″	Dark grayish brown loam to clay loam, moist, moderate medium prismatic breaking to a weak fine blocky structure; hard, friable, sticky and plastic; strong lime zone; thin continuous clay films on vertical faces.
9″ - 32″	Dark grayish brown clay loam, moist, weak medium and coarse prismatic structure; hard, friable, sticky and plastic, high lime.
32″ - 60″	Light brownish gray to olive grayish brown light clay loam till, extremely hard when dry; firm, sticky and plastic when moist; slight lime; mildly alkaline; with slight to moderate soluble salts; numerous nests of gypsum.

The soils in the lower portion of the undulating topography have a thicker solum over the "C" horizon, and a darker brown color. The depth to till will average 48″ to below 60″. The areas occupied by these deeper soils are not large enough to delineate separately.

The geologic formations of Liberty County include glacial lake deposits. The meltwater drained into natural drainages and the sand, silt and clay were moved by water and settled into the present fans, terraces and slightly undulating glacial plains of the present time. The soils consist of deep calcareous, predominantly silty clay loam sediments deposited as alluvium, and glacio-lacustrine material over the original bedrock. The texture, structure, and depth of the material over bedrock varies and only the soils with adequate subsurface drainage are considered irrigable. The recent erosion and formation of the soils of these areas have altered the flat topography into slight undulations and minor drainage channels. The two predominant irrigable soils can be illustrated by the following typical soil profiles.

Profile A—These soils occupy the fans, terraces, and undulating to level glaciated plains.

0″ - 7″	Moist very dark grayish brown silty clay loam; moderate fine granular structure, friable.
7″ - 10″	Dark brown moist heavy silty clay loam or light silty clay; strong medium prismatic breaking to strong fine and very fine blocky structure, friable, sticky and plastic, thick continuous clay films; noncalcareous; clear boundary.
10″ - 14″	Dark grayish brown light silty clay, moist, strong medium prismatic breaking to strong medium and fine block structure; very hard, friable, sticky and plastic, thick continuous clay films; noncalcareous; clear boundary.
14″ - 18″	Olive brown moist silty clay loam; strong medium prismatic structure separating to moderate fine and medium blocks; friable, sticky and plastic; very thin discontinuous clay films; calcareous, gradual bonndary; 3″ to 5″ thick.
18″ - 34″	Olive moist silty clay loam; moderate medium and coarse prismatic structure; very friable, sticky and plastic; calcareous with soft lime nodules; diffused boundary; 12″ to 18″ thick.

34″ - 60″ Olive moist silty clay loam, with few thin strata of silt loam; massive structure; very friable, sticky and plastic; calcareous.

The principal soil variations are that the materials below 30″ may become more stratified or they may consist of firm heavy clay loam till. The areas of clay loam till are continuous in some areas and may cause questionable drainage.

There are large acreages of clay soils in Liberty County. The clay textured soils are generally not considered too satisfactory for irrigation. The limiting factors are poor drainage and high salinity. The exceptions are an approximate 37,400 irrigable acres of heavy textured soils occurring on upland plains or on valley terraces with a high shrink-swell capacity which allows adequate drainage and aggregation for irrigation. Large areas of these soils occur on terraces and uplands above the Marias River and Tiber Reservoir.

A typical soil profile of the irrigable clay soil is as follows:

Profile B

0″ - 6″ Dark grayish brown moist clay; strong very fine granular structure; granules friable, sticky and very plastic; crust on surface 1/32″ thick forms after hard rain; slightly calcareous; abrupt boundary of cultivation.

6″ - 11″ Dark grayish brown moist clay; structure of strong coarse blocks easily separated to fine angular blocks; very hard, firm, sticky and very plastic; flat faces of blocks have glossy appearance; tongues of dark grayish brown soil 1/8″ to 1/2″ thick form fine geometric patterns on the horizontal surface just below the plow depth; slightly calcareous, gradual boundary.

11″ - 27″ Dark grayish brown moist clay; structure of strong coarse blocks easily separated to moderate very fine angular blocks; very hard, firm, sticky and very plastic; slickensides with intersecting surface 20 to 40 degrees from horizontal are very common and have surfaces 6″ to 10″ in diameter observed in moist soil; slightly calcareous; clear smooth boundary. The "A1" horizon is 18″ to 34″ thick.

27″ - 48″ Very dark gray moist clay; structure of moderate very coarse prisms easily separating to moderate very fine granules; very hard, firm, sticky and very plastic; thick large patches of organically stained clay films on some prism faces; small clusters of gypsum crystals, slightly calcareous.

48″ - 74″ Very dark moist clay; structure of moderate very coarse prisms in which gray and light gray very fine granules are distinct but held firmly in place; very hard, firm, sticky and very plastic, thick large patches of organically darkened clay films on some prism faces; small clusters gypsum crystals slightly calcareous.

Clay is the dominant texture of the Marias Series. Following hard rains on fallow ground, a thin (approximately 1/4″) fragile crust forms that does not bear handling and in which the form of granules are distinct. Clay plus silt ranges from 80 to 98 percent in all horizons between 8″ to 30″. Silt laminations may occur in the clay below 30″. Rounded and sub-angular stones, cobbles and gravel comprise up to 10 percent in total volume of upper soil horizons in glaciated areas of this soil. In these areas medium and coarser sands may comprise up to 10 percent of the soil less than 2 mm. in size. Clay in the sub-soil horizons range from about 50 to 75 percent. Profiles are slightly or moderately saline below depths of about 20″.

Marias clays occur on upland plains or on valley terraces and the soils consist of thick clay materials. These clay materials have a high shrink-swell capacity. The clays are well drained; surface runoff is medium; permeability is very slow in the wet soil and infiltration into the dry soil is medium to rapid.

Comparative Investigations

The development of large acreages of irrigated land in northern Montana has been in the existing stream valleys of recent alluvial soils. The small acreages of irrigated glacial soil do not furnish an adequate basis for comparative studies to potential irrigable dryland areas. The glacial age did not follow international boundaries and the southern portion of the Alberta Province of Canada is similar in topography, soils, drainage and climate to Liberty County. The large irrigated areas near Lethbridge, Alberta, have glacial soils which are similar to the dryland areas of Liberty County. The glacial soils have been irrigated for 40 years in some areas. The irrigated crops are sugar beets, alfalfa, field and canning peas, sweet corn, potatoes, small grains and vegetables. In general the yields of these crops are satisfactory and irrigation is a profitable agricultural enterprise.

The Soil Scientists of the Montana Water Resources Board reviewed the irrigation of glacial soils of Canada with the Soil Science Section of the Canada Department of Agriculture Research Station; and the Agrohydrology Branch of the Water Resources Division, Alberta Department of Agriculture, both agencies are located in Lethbridge, Alberta. The main conclusion that was determined at the meeting was that the glaciated area of northern Montana compares more closely with irrigation in southern Alberta than with other irrigated areas of the United States. Therefore, the future methods of potential irrigation, drainage, soil problems and future irrigated crops of Liberty County should be similar to those practiced in southern Alberta.

The Soil Scientists and Agricultural Engineers at Lethbridge, Alberta, have accomplished a large quantity of useful research studies on irrigated areas within their boundaries. Several conclusions of these studies can be applied to the north-central Montana area.

First, and most important is that proper planning and studies are necessary before irrigation can prove itself as a profitable agricultural enterprise. The reconnaissance land classification survey is considered only as a primary indication of an area's potential for future irrigation, and a comparison of other nearby proven irrigated areas will help determine the accuracy of predicting the potential of an area for irrigated agriculture. Second, the irrigated areas of Alberta, Canada, are similar to the glacial plains of Liberty County, and by considering the characteristics of their soils, topography and drainage features of irrigated lands the following conclusions emerge:

1. If the glacial plains of northern Montana were irrigated the area would be similar to southern Alberta, however, both would differ from most of the world's irrigated areas in that the surface ground is frozen three to five months of the year. During this period no water is being added but sub-drainage may continue below the frost level.

2. The irrigation of soils underlain by glacial till is practical if adequate constructed drainage is provided; however, the areas which the till is less than 36″ from the ground surface are not irrigable due to excessive drainage costs.

3. The glacial soils underlain by till require careful water management, excessive irrigation is not permissible due to the slow permeability of the sub-stratum. The farmers of Alberta do not use

excess water, the amount and frequency of rainfall is considered, and the crops are irrigated generally whenever 50 percent of the soil moisture has been depleted.

4. In the soils of the glacial plains of northern Montana and southern Alberta, Canada, the evaporation and evapotranspiration during the year normally are less than most irrigated areas of the United States and consequently there is less upward movements of salts. Therefore, if adequate drainage is maintained glacial soils can be irrigated and the crops can be successfully produced for many years. Adequate drainage should be considered but it may be necessary to construct tile drainage with a depth of tile at about 36", more or less, and 30 foot spacings between tile lines. It is understood that this type of drainage system is costly, however, as the value of irrigated crops and land increase in the future the high drainage costs may be acceptable.

5. The glacial soil underlain by till requires proper laboratory evaluation before irrigation. Soil sampling is essential for this laboratory testing to determine the salinity, alkalinity, and permeability. The irrigated soils near Lethbridge, Alberta, were tested and whenever the exchangeable sodium (measured by the sodium adsorption ratio method) was greater than 12 the land generally showed poor drainage, high alkalinity and restricted crop growth.

Sub-Surface Drainage

The drainage of shallow glacial till soil is the most critical item of consideration in irrigation planning. The feasibility of irrigating an area depends upon adequate protective measures to keep the crop production at a high level for a sustained irrigated agriculture. The absence of constructed drainage will cause the water table to rise, and the salt from the soil and irrigation water to accumulate within the root zone. The construction of drainage, mainly tile drains, will prevent salinization of the root zone. Research experiments in Canada proved that shallow tile drains at 36" depth, and spacing as close as 30 feet apart may be needed to adequately drain the shallow till soils.

The detail studies of an irrigation project should include a drainage survey to determine the costs of minimizing seepage and salinization of the soil. It should be remembered that soil which has become seeped and high alkalinity and salinity results to the point where crop production is curtailed is a waste of irrigated or dryland cultivated land.

Non-Irrigable Glacial Soils

The glaciated plains area of the county have large areas of soils developed over alkaline shaley glacial-drifts that are characterized by irregular bare spots, also known as slick spots and blowouts. The larger areas of these soils occur southwest of Chester along the Hill County line and in the southern portion of the county, generally south of the Marias River.

The alkaline bottoms of glacial lakes and some of the bottoms of the pre-glacial stream valleys have scabby, slick spot soils. The beneficial use of the alkaline slick spot soils are for dryland cultivation and livestock grazing, depending upon the percentage of the surface-exposed slick spots.

The dryland cultivated areas of Liberty County cannot always be considered as irrigable land. The heavy clay loam and clay glacial tills may have a high exchangeable sodium content, or a bulk density in excess of 1.5 grams per centimeter which will not allow sufficient vertical or horizontal movement of subsurface water to prevent seepage and high salinity build up in irrigated lands. There

are large acreages of heavy clay loam and clay tills underlying the surface soils at a depth of 24" to 48" which are beneficial for dryland cultivation and livestock grazing. However irrigation of these areas is not recommended.

Residual Soils

The residual soils of Liberty County are divided into two separate origins; the mountainous non-glacial slopes of the Sweet Grass Hills, and the areas of sedimentary shales and sandstones in the northern part of the area and along the Marias River.

The mountainous non-glacial slopes of the Sweet Grass Hills have stony loams at elevations above 4,500 to 5,000 feet. Portions of these slopes have shallow loamy, rocky soils developed over the parent material of sandstones and shales. The size and extent of the residual soils are not significant because of the intermixing of deeper soils of alluvial-colluvial origin. The beneficial use of the rocky slopes generally is for livestock grazing.

The soils developed over sedimentary shales and sandstones are locally immature. These olive-brown heavy clays are without distinct soil horizons and usually have the platy structure of the shales below 1' to 3'. Beneficial use of the land is livestock grazing.

Alluvial Soils

The Marias River Valley is the only source of large tracts of irrigable alluvial soils in the county. In Liberty County there are 1,180 acres of irrigable alluvial soils along the Marias River which flows in a southeasterly direction in a deeply entrenched valley 1/2 to 1 mile in width. Although in general appearance the valley floor is fairly level, it is very uneven in many places.

Recent deposits of alluvium have built up the land bordering the present stream course so that it may be actually a few feet higher than some of the land farther away from the stream; old ox-bows representing former channels of the river are filled with heavy textured soils and sometimes are filled with water part of the year. These depressions plus the present meandering stream course divide the irrigable land into very irregular areas which interfere somewhat with its use. The alluvial deposits of the tributary streams cause non-irrigable rough gravel and shale debris areas which are washed-in material overlying the original river terraces.

There are several areas of light to medium textured alluvial soils in the Marias Valley where irrigated agriculture is proving profitable. Additional pumping plants are needed to enhance the agricultural benefits of these tracts. The main limiting factor that should be considered in irrigation planning is the general topography of the area adjacent to the river; the meandering stream channel interferes with efficient irrigation systems. The areas of irrigable land are therefore small and generally can be considered only for limited river-pump irrigation by individual farmers.

The majority of small streams of Liberty County head in the Sweet Grass Hills and flow through narrow deeply entrenched valleys of the mountainous terrain, then broaden to an average width of 1/4 mile through the rolling uplands. The alluvial soils of these valleys have scabby land with slick spots, high alkaline content and seeped areas; the most beneficial use of the soil in these valleys is livestock grazing.

SUMMARY

The 1,459 square miles in Liberty County are basically utilized for dryland farming and livestock grazing which is the main adaptable agriculture for the "Triangle" area of northern Montana. Wheat is the basic dryland crop and should remain so for some time. Irrigation would be very beneficial to the economy, however, the limited water supply hinders expansion. The ultimate development of any large acreage of irrigation would depend on importing water from another area. The reconnaissance studies of the land classification survey show approximately 410,180 acres being suitable for irrigation planning; a further breakdown of the type of irrigation, either sprinkler or gravity, was not attempted by this survey. Considering the generalities of a reconnaissance study, it is probable that detail studies would decrease this irrigable acreage as much as 40 percent in some instances. It should be noted that any irrigation development would warrant a detail study of the soil, topography and drainage for the purpose of evaluating the project area to withstand a sustained irrigated agriculture.

The glacial soils of the county are adaptable to irrigation development; a comparative area of large irrigated acreage is only a few miles north of the International Boundary, these are the irrigated farms near Lethbridge, Alberta. The irrigated economy of the Lethbridge area is very productive; the main crops are sugar beets, field and canning peas, alfalfa, potatoes, small grains, irrigated pasture, and sweet corn.

The local Federal and State Agricultural Agencies have available soil surveys, and experimental information which help in determining areas for future irrigation and management of presently irrigated lands within Liberty County. Contacting these Agencies will help individual farmers save money and labor, and also conserve the land for future use.

References

Bowser, W. E., Peters, T. W., Kjearsgaard, A. A.; Soil Survey of eastern portion of St. Mary and Milk Rivers Development Irrigation Project: Canada Department of Agriculture in co-operation with the Research Council of Alberta and the University of Alberta, Edmonton: Alberta Soil Survey Report No. 22, 1963.

Committee of the Canada Department of Agriculture; Handbook for Classification of Irrigated Land in the Prairie Provinces: Printed and distributed by Prairie Farm Rebabilitation Administration, Regina, Saskatchewan, 1964.

Geiseker, L. F.; Montana Agricultural Experiment Station; Soil of Toole and Liberty Counties; Soil Reconnaissance of Montana: Montana State Agricultural Experiment Station Bulletin No. 273, April 1923.

Geiseker, L. F., and Morris, E. R., Montana Agricultural Experiment Station: Strahorn, A. T., and Manifold, C. B.; Soil Survey (Reconnaissance of the Northern Plains of Montana), United States Department of Agriculture Bulletin Series 1929, Number 21.

Mancini, A. J., Montana Water Resources Board: Groundwater, Water Resources Survey Liberty and Toole Counties; Water Resources Board Publication, 1969.

Acknowledgments

Anderson, Arial, Area Soil Scientist, Soil Conservation Service, Chinook, Montana. Contribution of soil information and field work in Liberty County, Montana, November 1968.

Vollrath, Robert R., Work Unit Conservationist, Soil Conservation Service, Chester, Montana. Contribution of information and soil survey aerial photographs in Liberty County, Montana, November 1968.

Dr. MacKay, D. C., Head Soil Science Section; and Soil Scientist Staff: Canada Department of Agriculture, Research Station, Lethbridge, Alberta. Contribution of research data and discussion of irrigated soils, Southern Portion of Province Alberta, Canada, January 1969.

Steed, Glen L., Branch Head; and Soil Scientist Staff, Alberta Department of Agriculture, Water Resources Division, Agrohydrology Branch, Lethbridge, Alberta. Contribution of research data and discussions on irrigated projects of the Province of Alberta, Canada, January 1969.

CROPS AND LIVESTOCK

Liberty County, located in north-central Montana, is 24 miles wide and approximately 60 miles long. The county covers an area of approximately 1,459 square miles. The Sweetgrass Hills are located in the northern portion of the county along the Canadian Border and are primarily used as a range livestock area. Covering an area of 933,120 acres, the county has about 368 operating farms. Tiber Dam is located in the south-central part of the county.

According to the 1964 United States Census of Agricultural Report, the average farm is approximately 3,040.2 acres in size with an average value per acre of approximately $61.27.

Liberty County's climate is generally classed as semi-arid, and the average growing season is 105 days.

The majority of the farms are dryland operations. The county has a total of 1,611 acres under irrigation at the present time. The irrigated land receives its water from Tiber Dam and runoff.

The major crops grown in the county are winter wheat, spring wheat, and barley. The largest acreage during normal years is planted to winter wheat, followed by spring wheat and barley. Some oats are grown, but the acreage normally is small.

The majority of the farms throughout the county follow the alternate crop and fallow system to build moisture reserves and carry out a weed control program. A large percentage of the dryland is strip cropped for erosion control, and stubble mulching is a universal practice. The entire county is included in a Soil and Water Conservation District with about 170 farmers cooperating under the program.

There is no organized weed control district in Liberty County, however, perennial noxious weeds are not a serious threat to crop production as yet. The county road crew sprays road right-of-way barrow pits.

The 1964 statistical report from the Agricultural Marketing Service lists a total of 14,948 cattle and calves raised in the county, 55 milk cows, 1,435 hogs and pigs, and 4,855 sheep and lambs. The cattle numbers remain quite constant with some farm feedlot feeding. The number being fed fluctuates with the price of feed barley and finished cattle.

There are no dairy herds in the county.

Hog production in the county is relatively stable with only a couple of large swine enterprises and a few small farm swine herds.

Sheep production has decreased in the past years and is somewhat stabilized to a few small farm flocks of the wool-type breeds.

Farm flocks of chickens and other poultry are continually declining in numbers.

The following is a summary of land use in the county: cultivated land, 549,491 acres; irrigated land, 1,611 acres; forest, 4,000 acres; range land, 334,488 acres; cities, roads, etc., approximately 3,600 acres.

Population of Liberty County is approximately 2,624, one of the smallest counties in the state, but has the highest per capita income.

STREAM GAGING STATIONS

The U. S. Geological Survey measures the flow of streams, co-operating with funds supplied by several state and federal agencies. The results have been published yearly in book form by drainage basins in Water-Supply Papers through the year 1960. Beginning with 1961, the stream-flow records have been published annually by the U. S. Geological Survey for the entire state under the title, "Surface Water Records of Montana." Data for 1961-65 and subsequent five-year periods will be published in Water-Supply Papers. Prior to general issuance, advance copies of station records may be obtained from the U. S. Geological Survey. That agency's records and reports have been used in the preparation of this resume'.

Data given below cover the stream gaging records, which are available for Liberty County from the beginning of measurements through the water year 1967. The water year begins October 1 and ends September 30 of the following year.

Following are equivalents useful in converting from one unit of measurement to another:

(a) In Montana, one cubic foot per second equals 40 miner's inches.

(b) One acre-foot is the amount of water required to cover an acre one foot deep.

(c) One cubic foot per second will nearly equal two acre-feet (1.983) in 24 hours.

(d) A flow of 100 miner's inches will equal five acre-feet in 24 hours.

(e) One miner's inch flowing continuously for 30 days will cover one acre 1½ feet deep.

For reference purposes, the stream gaging stations are listed in downstream order.

Marias River near Chester*

The water-stage recorder is 1 mile downstream from Tiber Dam, 4 miles upstream from Pondera Coulee, and 15 miles southwest of Chester. The drainage area is 4,927 square miles, of which 518 square miles is probably noncontributing. Records are available from April to September 1921 (at site 2½ miles downstream), October 1945 to September 1947 (at site 3 miles downstream), and October 1955 to date (1968) at present site. The maximum discharge was not determined, (occurred about March 20, 1947) and the minimum, probably less than 0.2 c.f.s. (October 29 to November 10, 1966), when gates at dam were closed. The average discharge for 14 years (1945-47, 1955-67) was 887 c.f.s. or 642,200 acre-feet per year. The highest annual runoff was 937,800 acre-feet (1967) and the lowest, 70,760 acre-feet (1956) when Tiber Reservoir was filling. Flow completely regulated by Tiber Reservoir since October 28, 1955. There are diversions for irrigation of about 65,000 acres above the station.

Partial Record Stations and Miscellaneous Discharge Measurements

In order to provide information on more streams than are covered by stream gaging stations, the U. S. Geological Survey has for several years been collecting some partial records. These are in addition to the miscellaneous discharge measurements which have always been reported. These partial records, when correlated with simultaneous discharges of nearby continuous-record stations, give fair indications of available flow.

There are three crest-stage partial-record stations in the Marias River Basin in Liberty County. Stations are now (1968) being operated on Marias River Tributary No. 3 near Chester, Cottonwood Creek Tributary near Chester, and Cottonwood Creek Tributary No. 2 near Chester.

The partial-record stations as well as the miscellaneous discharge measurements are listed at the end of each U. S. Geological Survey Water-Supply Paper or Surface Water Records report.

Reservoirs

Details of operation records for the following reservoir are available in the U. S. Geological Survey publications.

Tiber Reservoir near Chester*

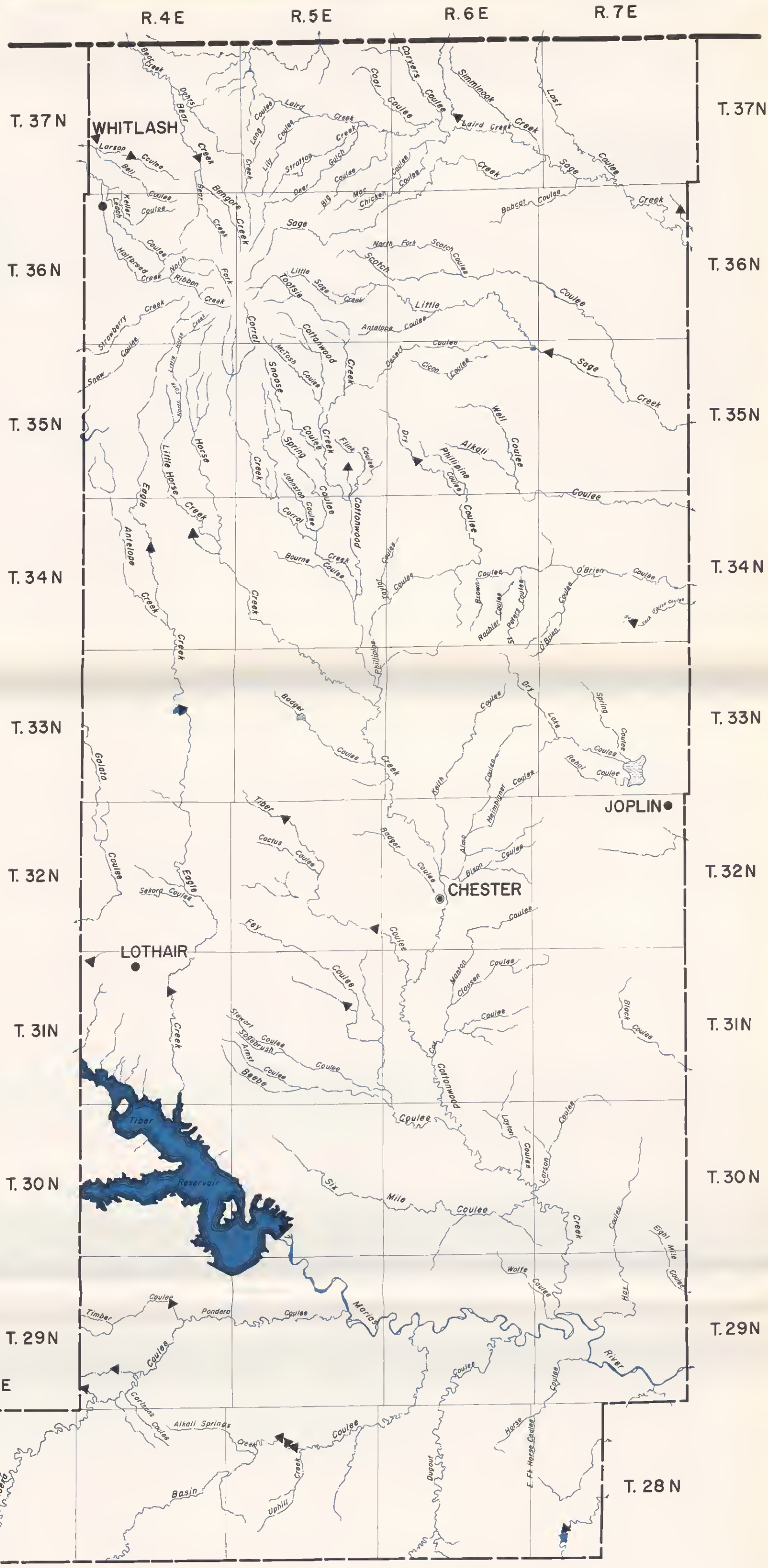
The tape and staff gages are located in the control house of river outlet tunnel at Tiber Dam on Marias River, 15 miles southwest of Chester. The drainage area is 4,923 square miles, of which 518 square miles is probably noncontributing. Records are available from October 1955 to date (1968). The maximum contents observed was 1,193,000 acre-feet (July 12, 13, 1965) and the minimum since first filling, 436,000 acre-feet (April 27 to May 2, 1967). Storage began October 28, 1955. The usable capacity is 1,347,000 acre-feet at controlled spillway elevation of 3,012.5 feet. Dead storage is 21,580 acre-feet below elevation 2,870 feet. Water is presently used for recreation and flood control.

*This station is now in operation (1968).

DAMS AND RESERVOIRS

The State of Montana has no statutes governing the design or construction of dams and, except for projects which the Montana Water Resources Board has constructed, the Board has no means of automatically obtaining information concerning design specifications, storage capacities, locations, or ownerships of dams and reservoirs built throughout the State. Consequently, steps have been taken to make this information available for use by the State, the Federal Government, and private citizens.

By means of a questionnaire, the Montana Water Resources Board recently obtained from the various federal agencies who design structures, the basic engineering data, locations, and ownerships of dams and reservoirs for which they either have, or had, responsibility and which have storage capacities of 50 acre-feet or more. The contributing federal agencies were the Soil Conservation Service, the Forest Service, the Bureau of Reclamation, and the Bureau of Land Management. The Montana Power Company also participated in the study.



LIBERTY COUNTY LOCATION MAP

Registry of Dams

LEGEND

- ▼ Dams 50 acre feet or more
- Major Lakes and Reservoirs
- Dry Lake Beds

Information on numerous dams and reservoirs constructed by private individuals in Montana is not available and is, therefore, omitted. However, the Board's Water Resources Survey crew, while working in Liberty County, obtained information on private dams and reservoirs within this county. The available information obtained from all sources was compiled by the Board for each county in the State and a list of dams and reservoirs which store 50 acre-feet or more of water was published.

GROUNDWATER

A. J. Mancini, Geologist

GEOLOGY

After a period of great earth movements and uplift some one million years ago, sheets of glacier ice moved into Liberty County from the north and west. Ice advanced and retreated intermittently until about 40,000 years ago at which time the retreat to the Polar region became more permanent. Remaining as testimony to this period of continental glaciation in the county is a mantle of earth material, for the most part unconsolidated, deposited by the ice or ice meltwater. Glacial-age deposits vary in thickness from a few feet to almost four hundred feet, and at present cover all of the county excepting East Butte of the Sweetgrass Hills and the higher ground of "Dobie Ridge." Portions of the floodplain of the Marias River and larger tributaries disguise underlying glacial deposits with a veneer of recent alluvium and fluvial gravels. There is sufficient evidence to presume the presence of many miles of buried valleys and stream channels under the Marias River floodplain and elsewhere that are filled with glaciofluvial deposits. These valleys and channels are vestiges of preglacial and glacial drainage systems. The present drainage system post-dates the glaciation period but apparently does resemble the earlier pattern in some respects. Excepting the Marias River, all streams in the county are reported as intermittent. A considerable portion of the Marias River is now backed-up behind the Tiber Dam.

If the glacial cover could be peeled off, the underlying outcrop pattern of bedrock formations would show the reflection of the east flank of a broad anticlinal dome, the Kevin-Sunburst Dome, and a fold known as the South (Sweetgrass) Arch. The configuration of the dome and arch is such that successively younger (deposited later in geologic time) sedimentary rocks are encountered in an eastward direction. A well drilled to sufficient depth in the northeastern part of the county would encounter sedimentary rocks underground that are of the same formation exposed farther west. Regional dip is about 50 feet per mile to the east. Structure has been punctuated in northwestern Liberty County by an igneous intrusion, whereby the form of a breached dome is apparent from the outcrop pattern of the unglaciated upland. This is East Butte, the predominant physiographic feature in the county, rising about 3,000 feet above the plain. Under the glacial cover are other structural features such as the Utopia nose plunging eastward, and smaller domes and "noses" most of which flank East Butte on the north and east. The arching of the bedrock, along with the development of local structure, and the igneous intrusion occurred prior to the glacial epoch.

AQUIFERS

Groundwater is available in both unconsolidated and consolidated sediments. Unconsolidated aquifers include recent alluvium and terrace deposits, glacial sands and gravels, and glaciofluvial valley fill. Consolidated aquifers include all the water-bearing bedrock and subsurface formations. The Eagle formation appears to be the most utilized source of groundwater. Individual aquifers are discussed in sequence of geologic age, the youngest or most shallow first and the oldest or deep-

est last. Water-well data have been taken from appropriation forms filed with the Groundwater Code Administrator, deep-well data from the records of the Oil and Gas Conservation Commission, and water-quality data from the records of the Department of Health.

Alluvium (Quaternary)—is stream, river, and lake deposits composed of silt, sand, gravel, and clay, mixed and interbedded, of recent geologic age and normally unconsolidated or only weakly cemented. In Liberty County these are narrow belts of thin floodplain deposits along the Marias River and some major tributaries, and low alluvial fans. Colluvium of streams at higher elevations is also included in this category. The thickness of alluvium is reported as only 14 feet in Tps. 29 and 30 N., R. 5 E., and the maximum thickness is probably not much greater. Alluvium locally is water-bearing but is too thin to be considered a reliable source of groundwater in the floodplain. Colluvium is water-bearing and probably is capable of providing small yields locally.

Terrace Deposits (Quaternary)—are mixtures of unconsolidated sands and gravels found locally along the Marias River, reportedly from 10 to 60 feet thick. These are not extensive enough to be considered reliable aquifers, but may serve as recharge areas for underlying glacial and fluvial sediments. Terrace remnants have been reported at four elevations, marking the transitory stages of the Marias River.

Glacial Deposits (Quaternary)—include a preponderance of till composed of dense grey, green, and brown clays; sands and gravels associated with local meltwater deposits; and glaciofluvial clastic material which accumulated in valleys and depressions. The glacial sequence may also include lake deposits. Within the impervious, unstratified heterogeneous till is at least one interval of boulders, as much as 30 feet thick.

Associated with the till are deposits of coarser material which can be utilized as aquifers if dependable sources of recharge exist. These permeable sands and gravels are meltwater deposits, usually linear in shape and of limited extent and thickness. They result from deposition by running water originating from melting glacier ice. As aquifers, glacial sands and gravels become important in areas where the underlying bedrock is a thick sequence of shale.

Valley fill is also a heterogeneous accumulation, but differs in that it contains intervals of sands and gravels of sufficient thickness to be considered important aquifers. Information is lacking, but apparently there were numerous channels in Liberty County which have been filled-in. Some of these would have been temporary channels during the glacial epoch, but others were preglacial valleys with significant collections of alluvium. The most important preglacial valleys were those of the ancestral east-flowing Marias River, and the south-flowing Cottonwood Creek, a tributary to the Marias. The two ancestral stems joined in western Hill County to form a now-buried Marias River valley which probably hosts aquifers capable of moderate yields, expected to be in the same range as those of the buried preglacial Missouri valley fill (perhaps as much as 300 gallons per minute per well). The preglacial valleys in Liberty County, from available data, were not as extensive as those in Hill County.

Other buried valleys are suspected along the present Laird Creek-Sage Creek-Lost Coulee system east of East Butte, and along Alkali Coulee and O'Brian Coulee in the east-central part of the county. Segments of temporary channels have been interpreted to be present throughout the county. North of East Butte wells reportedly have penetrated thick sequences of fluvial and lacustrine sediments as well as glacial deposits, including intervals of boulders. The thickest interpreted sequence is 400 feet, with five feet of water-bearing gravel at the base.

R.4E. R.5E. R.6E. R.7E.

T.37N. T.36N. T.35N. T.34N. T.33N. T.32N. T.31N. T.30N. T.29N. T.28N.

WHITLASH

LIMIT OF GLACIER ADVANCE

EAST BUTTE

LOTHAIR

CHESTER

JOPLIN

DOBIE RIDGE

Tiber Reservoir

TIBER DAM

R.3E. R.4E. R.5E. R.6E. R.7E.

EXPLANATION

- Flood Plain - Alluvium is very thin but may yield small amount of water locally; buried valley fill is a better aquifer.
- Terrace - Sand/gravel remnant of prior fluvial deposition; may contain aquifers of limited extent and rapid depletion.
- Buried Preglacial Marias River Valley - Valley fill may locally provide small to moderate yields.
- Buried Preglacial and Glacial Channels - Locally provide small yield.
- Tertiary Intrusives - May provide conduits for groundwater movement in recharge areas.
- Glaciated Plain, Bedrock Surface Predominantly Judith River Sandstone - Small yields from sandstone and overlying glacial material.
- Glaciated Plain, Bedrock Surface Predominantly Claggett Shale - Shale is not normally aquifer but small yields possible from overlying glacial material and underlying Eagle formation.
- Glaciated Plain, Bedrock Surface Predominantly Eagle Formation - Small yields from sandstones, particularly the basal Virgelle member, and overlying glacial material.
- Glaciated Plain, Bedrock Surface Predominantly Colorado Shale (including the Telegraph Creek Formation where applicable) - Shale is not normally an aquifer, but small yields possible locally from overlying glacial material.
- Unglaciated Upland, Bedrock Surface Predominantly Judith River Sandstone - Small yields possible locally, within the zone of saturation; small amount of recharge to Judith River sandstone possible.
- Unglaciated Upland, Bedrock Surface Predominantly Claggett Shale - Shale is not normally an aquifer.
- Unglaciated Upland, Bedrock Surface Predominantly Eagle Formation - Small yields possible locally, within the zone of saturation; small amount of recharge to Eagle sandstone possible.
- Unglaciated Upland, Bedrock Surface Predominantly Colorado Shale - Shale is not normally an aquifer, but springs are common.
- Unglaciated Upland, Bedrock Surface of Kootenai to Madison Formation - recharge area for certain subsurface artesian aquifers.
- (S) Reported Spring

MONTANA WATER RESOURCES BOARD

GROUNDWATER INVENTORY
LIBERTY COUNTY

COMPILED FROM DATA AVAILABLE AS OF AUGUST 1, 1968

Compiled from reports of U.S. Geological survey, the Montana Bureau of Mines & Geology, and others.

Geologist: A.J. Menzini
Asst'd by: R.J. Gunn
Drafted by: P.R. Vogel

Scale

2 mi. 6 mi.

Tertiary Intrusives—are masses of "granite" which pushed upward into overlying sedimentary rock strata prior to the glacial advance. These masses form the core of East Butte and now are exposed due to erosion of the overlying broken rock cover. The intrnsives are not aquifers but may condnct runoff into subsurface aquifers through fractures, and through conduits which developed at the igneous-sedimentary contacts.

Judith River Formation (Cretaceous)—is the youngest sedimentary bedrock in the county and is a sequence of tan-grey sandstones and shales, less than 100 feet thick in the outcrop as a result of uplift and erosion, and 400-600 feet thick in the subsurface thickening westward. Massive sandstones in the lower 200 feet of the formation contain the better aquifers. Individual sandstone units are lenticular, but the overall wide areal extent of the formation makes it an effective aquifer for small-yield wells. The sandstones are artesian aquifers and some wells have flowing yields.

Claggett Shale (Cretaceous)—is an interval of shale and shaley sandstone with cleaner sandstone in the upper part locally. A complete section is about 450 feet thick, thinning in a westward direction. This formation is not normally considered an aquifer, but may be water-bearing locally.

Eagle Sandstone (Cretaceous)—consists of two distinct members, an upper shaley unit and the lower Virgelle sandstone. The overall formation thickness is about 275 feet. The upper member may contain local aquifers within its 150-foot thickness; the lower Virgelle sandstone is an extensive aquifer. The Virgelle is fine to coarse grained massive sandstone, locally with thin interbeds of shale and lignite.

Colorado Shale (Cretaceous)—is a dark grey to black shale, not normally considered an aquifer, as much as 1,950 feet thick (including the **Telegraph Creek Formation** between the Colorado shale and Virgelle sandstone). Irregular sandstone stringers within the Telegraph Creek-Colorado sequence may be water-bearing locally. However, more commonly wherever this sequence constitutes the surface bedrock and overlying unconsolidated earth material is barren, it conld be necessary to drill 2,000 feet or deeper for water.

Kootenai Formation (Cretaceous)—is approximately 300-350 feet of sandstones and shales, and probably contains aquifers locally. Some of the sandstones within this interval produce oil.

Jurassic Interval—is 300+ feet of sandstone, shale, and limestone and includes crude oil reservoir rocks. Porous sandstones and limestones that do not contain oil might be tapped as sources of water, if the depth were not excessive and the water-quality not adversely affected by other formation fluid.

Madison Limestone (Mississippian)—is 1,000 feet or more of light-colored limestone having poor if any primary matrix porosity, but sometimes developing cavernous solution porosity at or near the top. The Madison provides large quantities of water for the secondary recovery of oil in nearby counties. Madison water reportedly is also used for "health and recreation" and small-scale irrigation in north-central Montana. Depth to aquifer has deterred greater development for non-industrial use.

Pre-Mississippian Rocks—include those of Devonian and Cambrian age. Within the more than 1,200 feet of Devonian section, the Jefferson formation contains carbonate intervals which probably could provide small to moderate well-yields. Development has not been attempted due to the risk

and the cost involved. Below the Devonian are rocks of Cambrian age, among which are limestones and sandstones that may be water-bearing. The deeper pre-Cambrian section has not been explored but could be water-bearing in fractures and cavities at depths exceeding 5,000 feet below the surface.

GROUNDWATER AREAS

Liberty County can be subdivided into at least three groundwater areas, based on physiography: the Marias River floodplain, the East Butte upland area, and the plains area.

Marias River Floodplain. The floodplain of the Marias River is a narrow band of very thin alluvium extending from the Tiber Dam eastward to the county boundary. Similar deposits are found along the southern tributaries to the Marias. Based on the appropriation forms of record, very few water wells have been drilled in the floodplain and these may actually be getting water from underlying buried valley fill of an ancestral valley. Due to the limited thickness of the recent alluvium (as reported), and much of this being silt, the floodplain probably is not as effective a groundwater area as might be expected. Of three wells reported as starting in the floodplain, one in Section 17, T. 29 N., R. 6 E., pumps 80 gpm (gallons per minute) for domestic purposes from a total depth of 12 feet; a second well pumps 3 gpm from a total depth of 150 feet; and the third pumps 50 gpm from a total depth of 36 feet. The latter two wells reportedly were drilled for use in connection with the Tiber Dam Reclamation Project.

East Butte Upland. The upland area characteristically is an area of intake for certain aquifers and hosts numerous springs in coulees and other low topographic expressions. Encroaching glacial ice did not reach the top of East Butte, but evidence indicates that flanking portions of the upland have been affected by the ice-age environment. North of East Butte are clusters of water wells which found water-bearing sands and gravels 160-400 feet below the surface. These sands and gravels appear to be within glaciofluvial and glacial-lacustrine deposits. Other wells west and south of the butte found glacial deposits as much as 125 feet below the surface, suggesting that melting-ice water may have flowed and/or collected along the northern, western, and southern flanks of East Butte. Locally the glacial deposits include more than 50 feet of permeable aquifer. Some wells reported hard cemented gravel at the base of the glacial material, and one well reported flammable gas in a gravel bed about 160 feet below the surface. The presence of natural gas is not regarded as unusual in view of the fact that several producing gas and oil fields are located on the flanks of East Butte.

The Plains Area. Much of Liberty County is rolling plains, trenched by intermittent drainages. All of the plains area with the exception of high topography of the "Dobie Ridge" has a mantle of glacial material. Groundwater is presently obtained from coarse material within the glacial deposits and from bedrock sandstones of the Judith River and Eagle formations. In the ancestral Cottonwood Creek valley, water is pumped out of valley-fill sands and gravels at depths of 10 to 150 feet. Another ancestral drainage system in northeastern Liberty County contains valley-fill sand and gravel aquifers at depths of 10 to 100 feet.

Judith River sandstone wells are mostly reported in the eastern portion of the county from T. 32N. to T. 37N., and Rgs. 6 and 7 East. The total depths are in the range of 150 to 225 feet. Several wells less than 100 feet deep are reported in T. 37N., R. 4E. Yields from the Judith River are reported in the range of 5-50 gpm.

The Virgelle member of the Eagle formation is the most utilized aquifer in the county. Wells have been drilled from 20 feet deep in T. 28N., R. 6E., to 828 feet deep in T. 37 N., R. 6E., in order to obtain water from the Virgelle. The common depth-range is 200-450 feet below the ground surface. Reported well-yields are in the range 5-75 gpm.. The municipal water supply for the town of Chester is augmented by water obtained from the Virgelle. The town of Chester has filed groundwater appropriation forms, claiming water from the Virgelle at depths of 398 and 442 feet in amounts of 45,000 to 50,000 gallons per day.

GROUNDWATER AVAILABILITY AND USE

Croundwater is used mainly for livestock, and for domestic purposes. A considerable amount of water intended for human consumption is hauled to the place of use, or in the case of Chester's primary municipal supply, carried by water-line from the Tiber Reservoir.

Water in unconsolidated aquifers at or near the surface generally has a lower amount of total dissolved solids than that in deeper bedrock. Total dissolved solids in the former have frequently been measured in amounts less than 1,000 ppm (parts per million) while the amounts in the Judith River and Eagle are reported as 2,500 to 7,200 ppm. Bedrock aquifers, even though containing greater amounts of dissolved minerals, are extensively used due to a measure of greater reliability inherent in the wide-range existence of relatively thick permeable intervals, and artesian pressure. In comparison the unconsolidated aquifers are irregular localized lenses of uncertain distribution and thickness, and in some areas are subject to rapid depletion. Almost everywhere in the plains area the Judith River and Eagle can be expected to provide small yields of water through wells. This in itself is significant to ranchers attempting to obtain water for livestock in remote localities. A few bedrock wells are reported to have small flow-yields, which are due to favorable combinations of surface topography and subsurface structure.

Groundwater is present in deep aquifers in discontinuous sandstones, and varying-litbology limestones and dolomites. The sandstones, Cretaceous and/or Jurassic in age, are difficult to delineate in the subsurface, and if water is found it may require pre-use treatment. The Madison limestone is reported present throughout the county, at depths of 2,000-3,500 feet below the land surface. Large quantities of water under artesian pressure can be expected from the Madison wherever cavernous and/or fracture permeability exists. An oil-exploration well in T. 31N., R. 4E., reported that a formation test at a depth of 2,200 feet resulted in a flow of 500 barrels per hour (350 gpm) of sulfurous water from the Madison. This water may not be suitable for any but industrial use without pretreatment, but a future potential is indicated if a need should exist.

The Jefferson dolomite is another wide-spread rock sequence at depths of 3,000-4,000 feet, which can contain artesian water if permeability is effective. An oil-exploration well in T. 30N., R. 5E., reported testing a water-flow of 200 barrels per day (5-6 gpm) from the Jefferson dolomite at a depth of 3,750 feet.

Present usage suggests that rural, domestic, and livestock needs will continue to be satisfied by water from unconsolidated aquifers and the Judith River and Eagle formations. Due to inferior quality of available groundwater in many localities, better-quality water will be desired for municipal use and preferred for domestic use, and will continue to be imported where possible. The development of deep aquifers such as the Madison limestone does not seem necessary at present excepting for an industrial use such as the secondary recovery of oil.

References

Alden, W. C., 1932, Physiography and glacial geology of eastern Montana and adjacent areas: U. S. Geological Survey Professional Paper 174.

Colton, Roger B., Lemke, Richard W., and Lindvall, Robert M., 1961, Glacial map of Montana east of the Rocky Mountains: U. S. Geological Survey Miscellaneous Geologic Investigations Map I-327.

Pierce, W. G., and Hunt, C. B., 1937, Geology and mineral resources of north-central Chouteau, western Hill, and eastern Liberty Counties, Montana: U. S. Geological Survey Bulletin 847-F.

Ross, C. P., Andrews, D. A., and Witkind, I. J., 1955, Geologic map of Montana: U. S. Geological Survey in cooperation with the Montana Bureau of Mines and Geology.

Smith, J. F., Jr., Witkind, I. J., and Trimble, D. E., 1959, Geology of the lower Marias River Area, Chouteau, Hill, and Liberty Counties, Montana: U. S. Geological Survey Bulletin 1071-E.

MONTANA BUREAU OF MINES AND GEOLOGY
GROUNDWATER DIVISION
WATER WELL INVENTORY

LIBERTY COUNTY

YEAR	A	C	D	F	H	I	N	P	S	R	T	U	X	Total
1940+ older					34	1	1	1	29	30			1	97
1941									1	1		1		3
1942					1									1
1943									3	2		1		6
1944									1	4				5
1945					1				1	6				8
1946									1			1		2
1947					4				1					5
1948					4				4	1				9
1949					1	1			5	3				10
1950					3				6	2				11
1951					2				4	3				9
1952					3				2	3				8
1953					3				3					6
1954					5					3				8
1955					6				5	1				12
1956					2				2	2			1	7
1957					5			1	1	3		1		11
1958					4			1	1	3				9
1959									1	3				4
1960					4				7					11
1961					7			1	12	2				22
1962					1				9	2				12
1963					2					3				5
1964									1					1
1965					2									2
1966									6					6
1967										1				1
Totals					94	2	1	4	106	78		4	2	291

A—Conditioning
C—Commercial
D—Dewatering
F—Fire Protection
H—Domestic
I—Irrigation
N—Industrial
P—Public Supply
S—Stock
R—Domestic and Stock
T—Institutional
U—Unused
X—Unknown

ECONOMIC MINERAL DEPOSITS

Geologic Situation

Liberty County is situated in the northwestern part of Montana's Great Plains fronting the Rocky Mountains, and occupies part of a broad plateau dissected by the east-flowing Marias River and its southeast-flowing tributaries. In the northern part of the County adjacent to the international border is the eastern extremity (East Butte) of a range of hills which the early half-breed hunters called Mountains of the Perfumed Hay, to be later translated by the traders of the Missouri region to the "Sweetgrass Hills." Mount Royal and Mount Brown of East Butte rise respectively to elevations of 6,914 and 6,958 feet, and are approximately 3,000 feet higher than the surrounding plain.

The greatest part of Liberty County is underlain by near-horizontal sandstone and shale, which in ascending order are the Colorado Shale, Telegraph Creek Formation, the Virgelle Sandstone Formation, Eagle Sandstone, Claggett Formation, and the Judith River Formation. In the eastern Sweetgrass Hills is exposed the Mississippian limestone (Madison Limestone), Jurassic Shale, limestone, and sandstone (Ellis Formation), and Lower Cretaceous shale and sandstone (Kootenai Formation).

Wisconsin glacial drift and glacial erratic pre-Cambrian boulders cover the adjacent plains, with drift deposits forming an irregular and undulating surface. Tertiary coarse-grained laccolithic masses and smaller dikes, sills, and plugs are intrusive into the sedimentary rocks with subsequent doming and bending of adjacent sedimentary strata.

Metallic mineral deposits of the county are confined to the eastern Sweetgrass Hills where copper, lead, zinc, gold, and iron are reported to occur largely in noncommercial quantities. The nonmetallic fluorspar lode deposits in this region contain minor amounts of barite, and silver and gold, the precious metals probably associated with iron disulfide (pyrite). Some production of placer gold and copper ore has been reported from the East Butte area, but the total amount is believed to have been small.

Metallic Minerals

Principal iron deposits occur at three properties at the head of Tootsie Creek, east of the summit of Mount Royal. At the M and M, Mountain Chief, and Malvina claims, magnetite and specularite form aggregates in limestone or in fracture zones in the syenite, the deposits localized near the contact of the intrusive and sedimentary rock. Chalcopyrite is associated with all iron deposits and some gold was reported produced from the Malvina property. No iron ore has been reported shipped from these East Butte claims.

Southwest of Mount Royal summit near the head of Ribbon Gulch is the Brown Eyed Queen mine and the Gagnon property. Small shipments of rich copper ore (bornite) have been made from the Brown Eyed Queen property, and the Gagnon property has produced some ore from galena-bearing fracture zones.

Nonmetallic Minerals

Fluorite occurs in the vicinity of East Butte in the Sweetgrass Hills. The largest known deposit is in the Tootsie Creek area, where fluorite concentrations are scattered over an area 2,000 feet long

by several hundred feet wide. The fluorite occurs in Madison Limestone adjacent to a syenite stock. At present no fluorite is being mined at this deposit.

Beds of bentonite are reported in the Claggett Shale, which crops out along a belt extending from the southeast corner to the northwest corner of the county.

Oil and Gas

Since the discovery of natural gas in Whitlash Field in November 1918, Liberty County has yielded about 4,550,000 barrels of oil and more than 64 billion cubic feet of natural gas. A total of 471 wells have been drilled in the search for oil and gas.

After the discovery of Whitlash Field, Bears Den Field was found in 1924, followed by Flat Coulee in 1928, Grandview in 1930, Utopia in 1943, Keith in 1945, and Mt. Lilly in 1964. In 1967, oil production averaged about 1,250 barrels per day and gas production about 18.2 million cubic feet per day. Production comes from rocks of Lower Cretaceous, Jurassic and Mississippian ages.

Exploration is still progressing at a steady pace. A total of 21 wells were drilled in 1967 of which 3 produced oil and 2 produced gas.

SOIL AND WATER CONSERVATION DISTRICTS

Liberty County is served by the Liberty County Soil and Water Conservation District which was organized June 3, 1950. The area of the Liberty County District is 921,165 acres.

The District is governed by a board of five supervisors who are elected by the land occupants of the county. They carry out a program of complete resource conservation, including erosion control, water conservation, soil management, and land improvement, wildlife management, recreation, land use adjustment. This program is accomplished by providing assistance to farmers and ranchers on a voluntary basis, by analyzing all resources, and by planning and applying economically sound conservation practices.

Under state law, the supervisors have the power to call upon local, state, and federal agencies to assist in carrying out a soil and water conservation program. The Liberty County Soil and Water Conservation District has a memorandum of understanding with the Soil Conservation Service and the State Forestry Department to provide technical assistance to District cooperators in carrying out a sound resource conservation program. Close working relations are maintained with the Extension Service, Agricultural Stabilization and Conservation Committee, Bureau of Reclamation, Board of County Commissioners, Department of the Interior, Montana Fish and Game Department, and the Department of State Lands and Investment.

The Soil Conservation Service assists the District by furnishing and interpreting basic data on soils, plant cover, and other features of the land. Technical data are interpreted to furnish alternate uses and treatments to aid District cooperators in carrying out a sound conservation program. It also aids District cooperators in performing operations requiring technical skills beyond the experience of the individuals involved.

The office of the State Forester cooperates with the District by coordinating the programs in shelterbelt and field windbreak tree planting. They cooperate with the District in conducting tours of tree plantings to stimulate interest of cooperators.

The Extension Service assists the District with its education and information program. An important function of the District is to inform landowners and occupants of the benefits derived from the wise use of land-water resources.

Technical phases of the District's program include detailed soil surveys, range site and condition surveys, ground water investigations, topographic and other engineering surveys. With the use of this basic resource information, proper land use and needed conservation treatment of each field can be determined. The technician interprets the surveys and provides the District cooperators with alternatives in land use and treatment that will enable him to treat the hazards and limitations that occur on each tract of land. With this information and by counseling with the technician, the farmer or rancher makes the final decision. These decisions are recorded in the Conservation Plan.

When the plan is completed, the cooperator is given further technical assistance in establishing the conservation practices called for in the plan. This technical assistance is provided without cost to the cooperating farmer or rancher.

At present there are 532,597 acres of privately-owned cropland, 329,992 acres of rangeland and tame pasture, 9,518 acres of woodland and 3,650 acres of other land on farms but not considered in the above categories. In addition, there are 22,747 acres of federal land, 12,191 acres of urban and built-up land and 1,840 acres of water surface.

It is estimated that 10,700 acres in the county can be irrigated. Most of the irrigation water would be obtained from the Marias River, proposed Marias-Milk River Canal, Sage Creek Coulee and the Cottonwood Creek watershed. At present there are about 938 acres under irrigation.

The major enterprises on agricultural lands are grain and livestock production. Livestock consists mainly of beef cattle, sheep and swine. Cash crops are small grains and hay.

On irrigated land the conservation effort consists largely of improvement of irrigation systems, land leveling, construction of permanent ditches, and improved pasture and hayland management.

On dryland pasture and range the effort has been to improve vegetative cover through seeding, deferred rotation grazing, fencing, livestock water development, and improvement of wildlife habitat.

Conservation on non-irrigated cropland has been accomplished by the establishment of conservation cropping systems, field windbreaks, grassed waterways, wind striperopping, and diversions.

The District owns a tree planter which is available to District cooperators on a rental basis for their tree-planting program.

The cooperative effort of conservation-minded landowners and operators, other groups, and agencies, have contributed to the overall success of the District.

FISH AND GAME

The Marias River was named by Lewis and Clark who thought it might be the main stem of the Missouri River. Sports fishing in Liberty County centers primarily around the Marias drainage. The headwaters of this stream on the eastern slopes of the Rockies afford trout fishing. Two Medicine River in Glacier Park, Cut Bank Creek, Birch Creek, Willow Creek and the main Marias River offer rainbow trout. Best trout fishing on the Marias River is immediately below Tiber Reservoir. Some trout are taken from the reservoir proper, but Tiber is more noted for excellent perch, rather than trout fishing. State parks on Tiber Reservoir offer access for fishermen, boaters, and other water-oriented forms of recreation.

In addition to trout, the upper Marias River is fished for sauger, whitefish, and northern pike. An occasional paddlefish is taken under special bowfishing regulations. Further downstream, near Loma, the Marias produces some excellent catfish.

Big game in Liberty County is limited to deer and pronghorned antelope. Though this is not one of the better big game areas in the state, some fine "mulie" bucks are found in the breaks along the Marias River.

Both upland game birds and waterfowl are found here in abundance. Sharptailed grouse and Hungarian partridge inhabit the grasslands and weedy coulees while pheasants frequent the agricultural areas. Both ducks and geese find Tiber Reservoir and the many farm ponds in the area to their liking. During late fall, Canada geese concentrate on Tiber Reservoir and feed in surrounding grainfields, providing some excellent goose hunting.

When the game hunting seasons are over, avid shooters keep their hunting eyes in condition by hunting rabbits. Coyotes, bobcats, foxes, and badgers offer some winter sport also.

SUMMARY OF IRRIGATED LAND BY RIVER BASINS IN THE FOLLOWING COUNTIES COMPLETED TO DATE

Big Horn, Blaine, Broadwater, Carbon, Carter, Cascade, Chouteau, Custer, Deer Lodge, Fallon, Flathead, Gallatin, Golden Valley, Granite, Hill, Jefferson, Judith Basin, Lake, Lewis & Clark, Liberty, Lincoln, Madison, Meagher, Missoula, Musselshell, Park, Phillips, Pondera, Powder River, Powell, Ravalli, Rosebud, Silver Bow, Stillwater, Sweet Grass, Teton, Toole, Treasure, Valley, Wheatland, Wibaux & Yellowstone.

RIVER BASIN Missouri River Drainage Basin	Present Irrigated Acres	Irrigable Acres Under Present Facilities	Maximum Irrigated and Irrigable Acres Under Present Facilities
*Missouri River	134,575.50	26,711.33	161,286.83
Jefferson River	61,291.00	9,173.00	71,004.00
Beaverhead River	40,771.00	6,076.00	46,847.00
Big Hole River	23,775.00	1,950.00	25,725.00
Madison River	39,445.00	7,660.00	47,105.00
Gallatin River	112,054.00	21,242.00	133,296.00
Smith River	32,934.00	19,679.00	52,613.00
Sun River	124,474.58	4,385.00	128,859.58
Marias River	125,199.42	17,267.88	142,467.30
Teton River	74,653.00	15,882.33	90,535.33
Musselshell River	64,789.00	57,870.00	122,659.00
Milk River	215,923.62	49,326.76	265,250.38
Yellowstone River**	303,657.00	96,016.00	399,673.00
Stillwater River**	30,423.50	8,028.53	38,452.03
Clarks Fork River**	88,160.97	1,530.83	89,691.80
Big Horn River**	65,005.00	23,858.00	88,863.00
Tongue River	28,170.00	7,762.00	35,932.00
Powder River	35,948.00	2,299.00	38,247.00
Little Missouri River	42,513.00	1,499.00	44,012.00
Grand Total Missouri River Basin	**1,643,762.59**	**378,756.66**	**2,022,519.25**
Columbia River Drainage Basin			
Columbia River	0.00	0.00	0.00
Kootenai (Kootenay) River	9,914.13	968.00	10,882.13
Clark Fork (Deer Lodge) (Hellgate) (Missoula) River	146,287.70	14,934.20	161,221.90
Bitter Root River	111,102.43	3,200.00	114,302.43
Flathead River	135,907.19	4,532.22	140,439.41
Grand Total Columbia River Basin	**403,211.45**	**23,634.42**	**426,845.87**
Grand Total Counties Completed to Date	**2,046,974.04**	**402,391.08**	**2,449,365.12**

*Names of streams indented on the left-hand margin indicate that they are tributaries of the first stream named above which is not indented.

**Figures in these river basins revised by resurvey of Carbon County, 1965.

IRRIGATION SUMMARY OF LIBERTY COUNTY BY RIVER BASINS

MISSOURI RIVER BASIN	Present Irrigated Acres	Irrigable Acres Under Present Facilities	Maximum Irrigated and Irrigable Acres Under Present Facilities
Missouri River	0.00	0.00	0.00
Marias River	1,589.00	730.00	2,319.00
Willow Creek	0.00	0.00	0.00
Eagle Creek	894.00	131.00	1,025.00
Antelope Coulee	0.00	0.00	0.00
Unnamed Coulee	10.00	0.00	10.00
Total Willow Creek & Tributaries	**904.00**	**131.00**	**1,035.00**
Unnamed Coulee	9.00	0.00	9.00
Unnamed Coulee	10.00	0.00	10.00
Basin Coulee	14.00	0.00	14.00
Dugout Coulee	38.00	0.00	38.00
Cottonwood (Government) (Sweetgrass Coulee) Creek	413.00	409.00	822.00
Tootsie (Toosie) Creek	177.00	0.00	177.00
Flink Coulee	51.00	0.00	51.00
Corral Creek	257.00	0.00	257.00
Unnamed Trib. Of Corral Creek	11.00	0.00	11.00
Davis (Grassy Draw) (Fork) Coulee	4.00	0.00	4.00
Horse Creek	90.00	0.00	90.00
North Fork Horse Creek	38.00	0.00	38.00
Unnamed Coulee	50.00	0.00	50.00
Troutwine Lake	33.00	0.00	33.00
Jackson Coulee	68.00	0.00	68.00
Alma Coulee	16.00	0.00	16.00
Keith Coulee	155.00	0.00	155.00
Cox Coulee	0.00	0.00	0.00
Manton (Poverty) Coulee	125.00	0.00	125.00
Total Cottonwood Creek & Tributaries	**1,488.00**	**409.00**	**1,897.00**
Hay Coulee	42.00	0.00	42.00
Black Coulee	0.00	0.00	0.00
East Fork Black Coulee	0.00	0.00	0.00
Rehal Coulee	5.00	0.00	5.00
Total Marias River & Tributaries	**4,099.00**	**1,270.00**	**5,369.00**
Milk River	3.00	0.00	3.00
Half Breed (Breed) Creek	96.00	41.00	137.00
Unnamed Lake	39.00	0.00	39.00
Ribbon (South Fork Half Breed) Creek	95.00	34.00	129.00
Keller Creek (Two Springs Creek)	31.00	0.00	31.00
Artesian Well	16.00	0.00	16.00
Leach (Keller) Coulee	80.00	0.00	80.00
Spring	40.00	0.00	40.00
Larson (Simmons) Coulee	151.00	0.00	151.00
Bell Creek (Spring Coulee)	30.00	0.00	30.00
Bear Creek (Beaver)	297.00	64.00	361.00
Bengore (Bangor) Creek	50.00	0.00	50.00
Long Coulee	4.00	0.00	4.00
Dohrs (East Fork Bear) (Spring) Creek	0.00	0.00	0.00
Unnamed Trib. of Dohrs Creek	4.00	0.00	4.00
Police Coulee	47.00	0.00	47.00
West Fork Police Coulee	0.00	22.00	22.00

*Names of streams indented on the left-hand margin indicate that they are tributaries of the first stream named above which is not indented.

IRRIGATION SUMMARY OF LIBERTY COUNTY BY RIVER BASINS

MISSOURI RIVER BASIN—(Continued)	Present Irrigated Acres	Irrigable Acres Under Present Facilities	Maximum Irrigated and Irrigable Acres Under Present Facilities
Big Sandy Creek	0.00	0.00	0.00
Sage Creek (Big Sage)	526.00	35.00	561.00
Laird Creek (Little Sage)	3.00	0.00	3.00
Simminook Creek	100.00	0.00	100.00
Deer Gulch	19.00	0.00	19.00
Carvers Coulee	0.00	0.00	0.00
Unnamed Coulee	30.00	0.00	30.00
Chicken Coulee	29.00	0.00	29.00
Mac Coulee	37.00	52.00	89.00
Unnamed Coulee	63.00	0.00	63.00
Lost Creek (Coulee)	19.00	0.00	19.00
Unnamed Coulee	11.00	0.00	11.00
Unnamed Coulee	2.00	0.00	2.00
Little Sage Creek	295.00	61.00	356.00
Scotch Coulee	39.00	0.00	39.00
North Fork Scotch Coulee (A Dry)	18.00	0.00	18.00
O'Brien Coulee	24.00	0.00	24.00
South Fork O'Brien Coulee	0.00	0.00	0.00
Soldier Coulee	42.00	0.00	42.00
Alkali (Four Mile))Coulee	8.00	0.00	8.00
Total Sage Creek & Tributaries	**1,265.00**	**148.00**	**1,413.00**
Total Milk River & Tributaries	**2,248.00**	**309.00**	**2,557.00**
GRAND TOTAL LIBERTY COUNTY	**6,347.00**	**1,579.00**	**7,926.00**

WATER RIGHT DATA—LIBERTY COUNTY

APPROPRIATIONS AND DECREES BY STREAMS

STREAMS	APPROPRIATIONS (Filings of Record) No. of Filings	Miner's Inches	Cu. Ft. Per. Sec.	DECREED RIGHTS Case No.	No. of Decrees	Miner's Inches	Cu. Ft. Per Sec.
MISSOURI RIVER BASIN							
Missouri River	0	0.00	0.00				
Marias River	21	100,040.00	2,501.00				
Unnamed Coulee	1	240.00	6.00				
Willow Creek	7	1,490.00	37.25				
Trail Creek	0	0.00	0.00				
Strawberry Creek	7	1,000.00	25.00				
Snow Coulee	2	300.00	7.50				
Kinyon Coulee	0	0.00	0.00				
Guernsey Run Coulee	1	200.00	5.00				
Galata Coulee	1	2,000.00	50.00				
Galata Spring	1	144.00	3.60				
Unnamed Coulee	2	3,200.00	80.00				
Lane Coulee	1	1,240.00	31.00				
Buffalo Coulee	1	24,000.00	600.00				
Unnamed Coulee	2	All	---				
Hall (Lamb) Coulee	4	24,440.00	611.00				
Unnamed Coulees	1	All	---				
Trumbull Coulee	1	200.00	5.00				
Unnamed Coulees	1	All	---				
Emerson Coulee	1	All	---				
Eagle Creek	41	51,224.80	1,280.62				
North Fork Eagle Creek	1	100.00	2.50				
Haws Creek	1	80.00	2.00				
Spring	1	---	---				
Flat Coulee	1	100.00	2.50				
Antelope Coulee	2	1,200.00	30.00				
West Branch Eagle Creek	2	500.00	12.50				
East Fork Eagle Creek	1	200.00	5.00				
Dead Coulee	1	200.00	5.00				
Dutro Coulee	1	200.00	5.00				
Sekora Coulee	1	200.00	5.00				
Bishop Coulee	1	200.00	5.00				
Smith Coulee	1	120.00	3.00				
Total Willow Creek & Tributaries	88	112,538.80	2,813.47				
Unnamed Coulee	1	280.00	7.00				
Pondera Coulee	1	400.00	10.00				
Showers Coulee	1	2,000.00	50.00				
Lytle Coulee	1	400.00	10.00				
Unnamed Coulee	1	40.00	1.00				
Unnamed Coulee	1	40.00	1.00				
Salty Spring Creek	1	500.00	12.50				
Carlson's Coulee	1	1,000.00	25.00				
Timber Coulee	2	1,200.00	30.00				
South Fork Timber Coulee	1	400.00	10.00				
Unnamed Coulee	1	200A.F.	---				
Total Pondera Coulee & Tributaries	11	5,980.00	149.50				

*Names of streams indented on the left-hand margin indicate that they are tributaries of the first stream named above which is not indented.

WATER RIGHT DATA—LIBERTY COUNTY

APPROPRIATIONS AND DECREES BY STREAMS

STREAMS	APPROPRIATIONS (Filings of Record) No. of Filings	Miner's Inches	Cu. Ft. Per. Sec.	DECREED RIGHTS Case No.	No. of Decrees	Miner's Inches	Cu. Ft. Per Sec.
Unnamed Coulee	2	300.00	7.50				
Unnamed Coulee	1	500.00	12.50				
Unnamed Coulee	2	300.00	7.50				
Unnamed Coulee	1	40.00	1.00				
Basin Coulee	7	1,340.00	33.50				
Higgins Coulee	1	200.00	5.00				
Miller Coulee	1	800.00	20.00				
Millers Coulee	1	800.00	20.00				
Alkali Spring Creek (Spring Coulee)	3	1,040.00	26.00				
Uphill Creek	2	600.00	15.00				
Dugout Coulee	2	320.00	8.00				
Unnamed Coulee	1	400.00	10.00				
Wolfe Coulee	1	200.00	5.00				
Cottonwood (Government) (Sweetgrass Cle) Creek	26	36,360.00	909.00				
Spring	1	100.00	2.50				
Spring Creek	4	690.00	17.25				
Tootsie (Toosie) Creek	5	580.00	14.50				
Snoose (Bell Spring) Coulee	2	200.00	5.00				
Flink Coulee	1	400.00	10.00				
Joiner Coulee	1	400.00	10.00				
Corral Creek	21	383,280.00	9,582.00				
Dry Fork Coulee	1	200.00	5.00				
Davis (Grassy Draw) (Fork) Coulee	3	490.00	12.25				
Spring Coulee	3	600.00	15.00				
Johnston Coulee	1	400.00	10.00				
Bourne Coulee	2	480.00	12.00				
Phillipine Coulee	2	600.00	15.00				
Dry Coulee	2	300.00	7.50				
Taylor Coulee	1	2,000.00	50.00				
Schudars Coulee	2	400.00	10.00				
Horse Creek	19	2,960.00	74.00				
Unnamed Coulee	1	80.00	2.00				
East Fork Horse Creek	3	520.00	13.00				
Alexander Coulee	1	100.00	2.50				
Little Horse Creek	3	600.00	15.00				
Unnamed Coulee	0	0.00	0.00				
Bourne and Hamilton Lake	1	800.00	20.00				
Unnamed Coulee	1	400.00	10.00				
Unnamed Coulee	0	0.00	0.00				
Troutwine Lake	1	8,000.00	200.00				
Badger Coulee	1	320.00	8.00				
Jackson Coulee	1	200.00	5.00				
Rock Coulee	3	720.00	18.00				
Alma Coulee	3	840.00	21.00				
Heimbigner Coulee	1	500A.F.	---				
East Fork Alma Coulee	5	630.00	15.75				
Bison Coulee	3	1,020.00	25.50				

WATER RIGHT DATA—LIBERTY COUNTY

APPROPRIATIONS AND DECREES BY STREAMS

STREAMS	APPROPRIATIONS (Filings of Record) No. of Filings	Miner's Inches	Cu. Ft. Per. Sec.	DECREED RIGHTS Case No.	No. of Decrees	Miner's Inches	Cu. Ft. Per Sec.
Clayton Coulee	1	200.00	5.00				
Coulee No. 6	1	160.00	4.00				
Coulee No. 2	1	160.00	4.00				
Coulee No. 3	1	160.00	4.00				
Coulee No. 4	1	160.00	4.00				
Coulee No. 5	1	160.00	4.00				
One Mile Coulee	1	200.00	5.00				
Coulee No. 1	1	160.00	4.00				
Keith Coulee	11	3,220.00	80.50				
Badger (Dry) Coulee	4	4,560.00	114.00				
Tiber (Fey) (West Branch Cottonwood Cr.)	10	20,520.00	513.00				
Cactus Coulee	1	150.00	3.75				
Tiber Gesche Coulee	1	400.00	10.00				
Cox Coulee	0	0.00	0.00				
Stellner Coulee	1	40.00	1.00				
Manton (Poverty) Coulee	5	14,680.00	367.00				
Clausen Coulee	1	200.00	5.00				
Nutt Coulee	1	240.00	6.00				
Fey (Twelve Mile Coulee)	8	1,900.00	47.50				
Sagebrush Coulee	1	200.00	5.00				
Beebe Coulee	1	100.00	2.50				
Arnst Coulee	1	320.00	8.00				
Unnamed Coulee	1	240.00	6.00				
Layton Coulee	1	400.00	10.00				
Kjar Coulee	2	340.00	8.50				
Larson Coulee	2	220.00	5.50				
Unnamed Coulee	1	200.00	5.00				
Stipp Coulee	4	17,200.00	430.00				
Moore Coulee	1	400.00	10.00				
Six Mile Coulee	3	1,460.00	36.50				
Rattlesnake Coulee	1	80.00	2.00				
Sweet Grass Coulee	1	400.00	10.00				
Unnamed Coulee	1	40.00	1.00				
Total Cottonwood Creek & Tributaries	**197**	**513,540.00**	**12,838.50**				
Hay Coulee	3	920.00	23.00				
Horse Coulee	2	8,000.00	200.00				
Dead Indian Coulee	0	0.00	0.00				
Unnamed Coulee	1	160.00	4.00				
Unnamed Coulee	1	200.00	5.00				
Depuyer Coulee	1	300.00	7.50				
Eight Mile Coulee	3	410.00	10.25				
Black Coulee	2	8,600.00	215.00				
Wilson Coulee	1	600.00	15.00				
Unnamed Coulee	1	8,000.00	200.00				
East Fork Black Coulee	0	0.00	0.00				
Rehal Coulee	4	710.00	17.75				
Dry Lake Coulee	4	9,300.00	232.50				
Spring Coulee	2	600.00	15.00				

WATER RIGHT DATA—LIBERTY COUNTY

APPROPRIATIONS AND DECREES BY STREAMS

STREAMS	APPROPRIATIONS (Filings of Record) No. of Filings	Miner's Inches	Cu. Ft. Per. Sec.	DECREED RIGHTS Case No.	No. of Decrees	Miner's Inches	Cu. Ft. Per Sec.
Doby Hill Coulee	2	1,000.00	25.00				
Total Marias River and Tributaries	372	778,258.80	19.456.47				
Milk River	0	0.00	0.00				
Half Breed (Breed) Creek	32	7,020.00	175.50	3054	1	360.00	9.00
North Fork Half Breed Creek	1	100.00	2.50				
Ribbon (South Fork Half Breed Creek)	8	1,670.00	41.75				
Porter Creek	4	680.00	17.00				
Keller Creek (Two Springs) Creek	11	1,420.00	35.50				
Spring Coulee	1	200.00	5.00				
Spring	1	120.00	3.00				
Leach (Keller) Coulee	1	100.00	2.50				
Hicks Coulee	1	200.00	5.00				
Thompson Springs	1	40.00	1.00				
Larson (Simmons) Coulee	5	960.00	24.00				
Bell Creek (Spring Coulee)	5	560.00	14.00				
Spring	1	120.00	3.00				
Bear Creek (Beaver)	30	8,031.00	200.78				
Bengore (Bangor) Creek	7	920.00	23.00				
Long Coulee	1	100.00	2.50				
Dohrs (East Fork Bear) (Spring) Creek	8	1,080.00	27.00				
Waites Coulee	1	40.00	1.00				
South Coulee	1	100.00	2.50				
North Coulee	2	280.00	7.00				
Police Coulee	10	2,240.00	56.00				
North Fork Police Coulee	1	100.00	2.50				
South Fork Police Coulee	2	400.00	10.00				
West Fork Police Coulee	2	700.00	17.50				
Prey Coulee	1	80.00	2.00				
Big Sandy Creek	0	0.00	0.00				
Sage Creek (Big Sage)	28	25,090.00	627.25				
Black Jack Spring	1	300.00	7.50				
Laird Creek (Little Sage)	6	8,620.00	215.50				
Long Coulee	1	100.00	2.50				
Stratton Creek	0	0.00	0.00				
Deer Gulch	1	200.00	5.00				
Big Coulee (South Fork Deer Gulch)	4	1,100.00	27.50				

WATER RIGHT DATA—LIBERTY COUNTY

APPROPRIATIONS AND DECREES BY STREAMS

STREAMS	APPROPRIATIONS (Filings of Record) No. of Filings	Miner's Inches	Cu. Ft. Per. Sec.	Case No.	DECREED RIGHTS No. of Decrees	Miner's Inches	Cu. Ft. Per Sec.
Northwest Coulee	1	60.00	1.50				
Chicken Coulee	0	0.00	0.00				
Waste Water	2	8,240.00	2.06				
Bobcat Coulee	2	160.00	4.00				
Lost Creek (Coulee)	1	200.00	5.00				
Ware Coulee	1	20.00	0.50				
Russell Coulee	0	0.00	0.00				
Silver Lake	1	400.00	10.00				
Little Sage Creek	27	7,590.00	189.75				
Lebanon Coulee	2	440.00	11.00				
Antelope Coulee	2	600.00	15.00				
Desert (Keith) (Spring) Coulee	4	620.00	15.50				
Unnamed Coulee	1	400.00	10.00				
Cicon Coulee	4	1,800.00	45.00				
Keith Coulee	1	800.00	20.00				
Scotch Coulee	13	9,850.00	246.25				
Spring	2	960.00	24.00				
North Fork Scotch Coulee (A Dry)	1	2.40	0.06				
A Dry Coulee	1	2.40	0.06				
Unnamed Coulee	1	80.00	2.00				
Spring	1	80.00	2.00				
Unnamed Coulee	1	All	---				
O'Brien Coulee	3	700.00	17.50				
Brown Coulee	1	100.00	2.50				
Coons Coulee	1	200.00	5.00				
Rochler Coulee	1	200.00	5.00				
St. Peters (C & D) Coulee	2	1,100.00	27.50				
Mudget Coulee	1	200.00	5.00				
Alkali (Four Mile) Coulee	5	1,440.00	36.00				
Dry Coulee	1	100.00	2.50				
Well Coulee	2	800.00	20.00				
Total Sage Creek and Tributaries	**127**	**64,397.20**	**1,609.93**				
Total Milk River and Tributaries	**265**	**91,658.20**	**2,291.46**		**1**	**360.00**	**9.00**
GRAND TOTAL LIBERTY COUNTY	**637**	**869,917.00**	**21,747.93**		**1**	**360.00**	**9.00**

DRAINAGES IN LIBERTY COUNTY NOT LOCATED

STREAMS	No. of Filings	Miner's Inches	Cu. Ft. Per Sec.
Chicks Coulee	1	80.00	2.00
Hawley Creek	1	40.00	1.00
Little Cottonwood Creek	1	200.00	5.00
Rosa Creek	1	150.00	3.75
Strode Coulee	1	300.00	7.50
South Fork Twelve Mile Coulee	1	1,000.00	25.00
Umphrey Creek	1	120.00	3.00
Antelope Spring	1	200.00	5.00
Corall Spring	1	30.00	0.75
Daisy Spring	1	100.00	2.50
Two Springs	1	40.00	1.00
TOTAL	11	2,260.00	56.50

WATER RESOURCES SURVEY

Liberty County, Montana

PART II

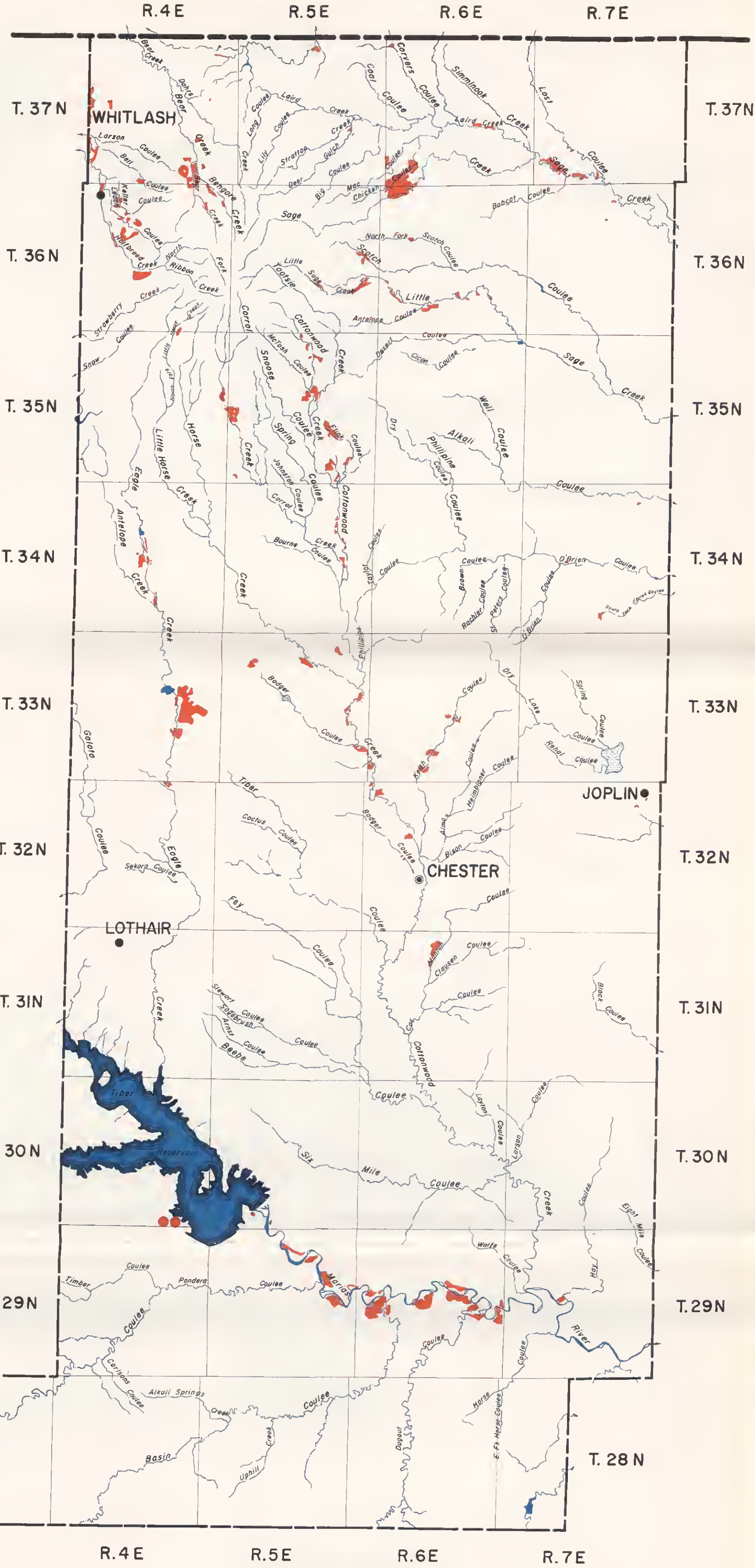
Maps Showing Irrigated Areas in Colors
Designating the Sources of Supply

Published by
MONTANA WATER RESOURCES BOARD
Helena, Montana
June, 1969

MAP INDEX

All maps have been made from aerial photographs

ALBERTA



DRAINAGE MAP
of
Liberty County
Showing Irrigated Areas

MAP SYMBOL INDEX

BOUNDARIES

- COUNTY LINE
- NATIONAL FOREST LINE

DITCHES

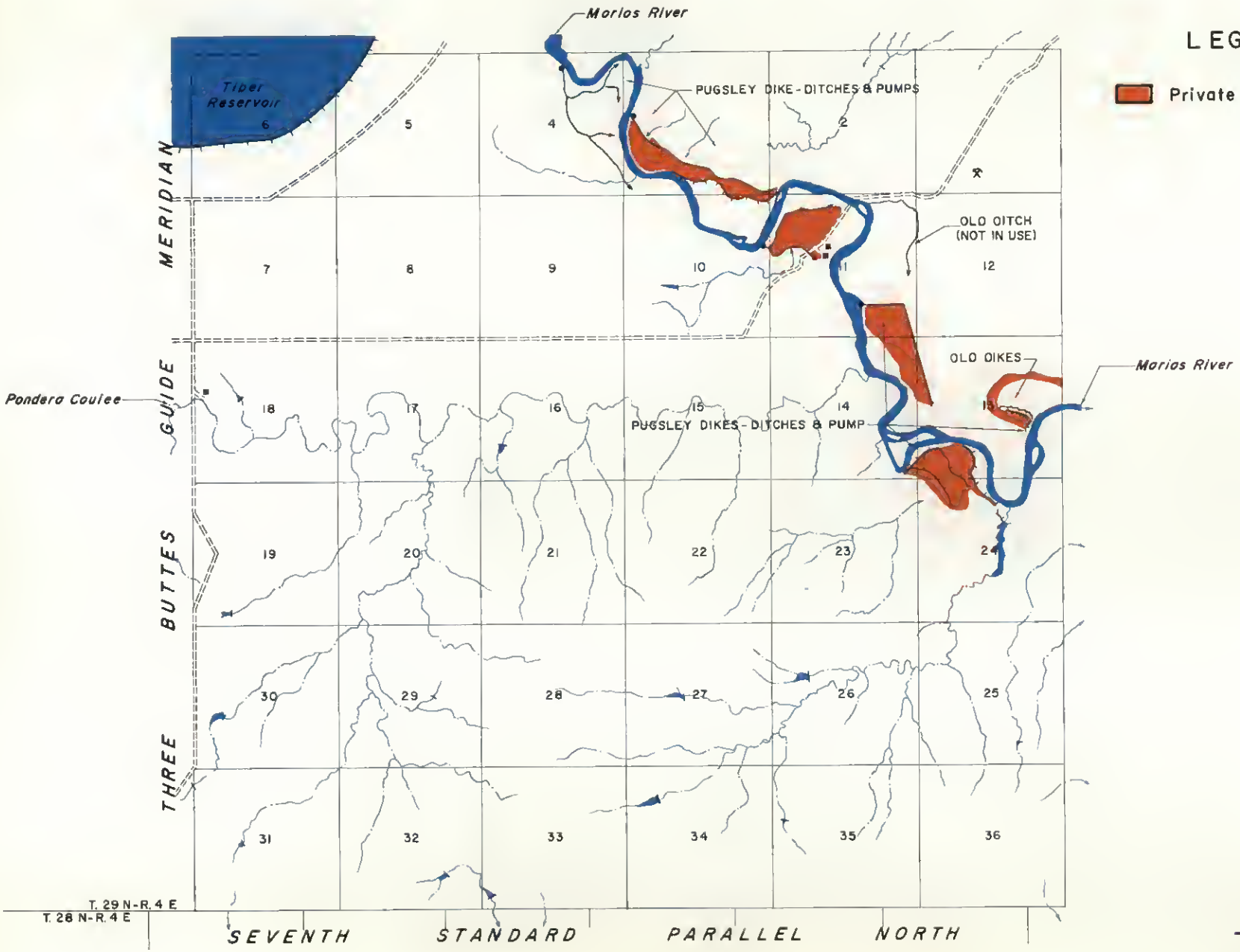
- CANALS OR DITCHES
- DRAIN DITCHES
- PROPOSED DITCHES

TRANSPORTATION

- PAVED ROADS
- UNPAVED ROADS
- RAILROADS
- STATE HIGHWAY
- U.S. HIGHWAY
- AIRPORT

STRUCTURES & UNITS

- DAM
- DIKE
- FLUME
- SIPHON
- SPILL
- SPRINKLER SYSTEM
- WEIR
- PIPE LINE
- PUMP
- PUMP SITE
- RESERVOIR
- WELL
- NATURAL CARRIER USED AS DITCH
- SPRING
- SWAMP
- GAUGING STATION
- POWER PLANT
- STORAGE TANK
- CEMETERY
- FAIRGROUND
- FARM OR RANCH UNIT
- LOOKOUT STATION
- RANGER STATION
- RAILROAD TUNNEL
- SCHOOL
- SHAFT, MINE, OR DRIFT

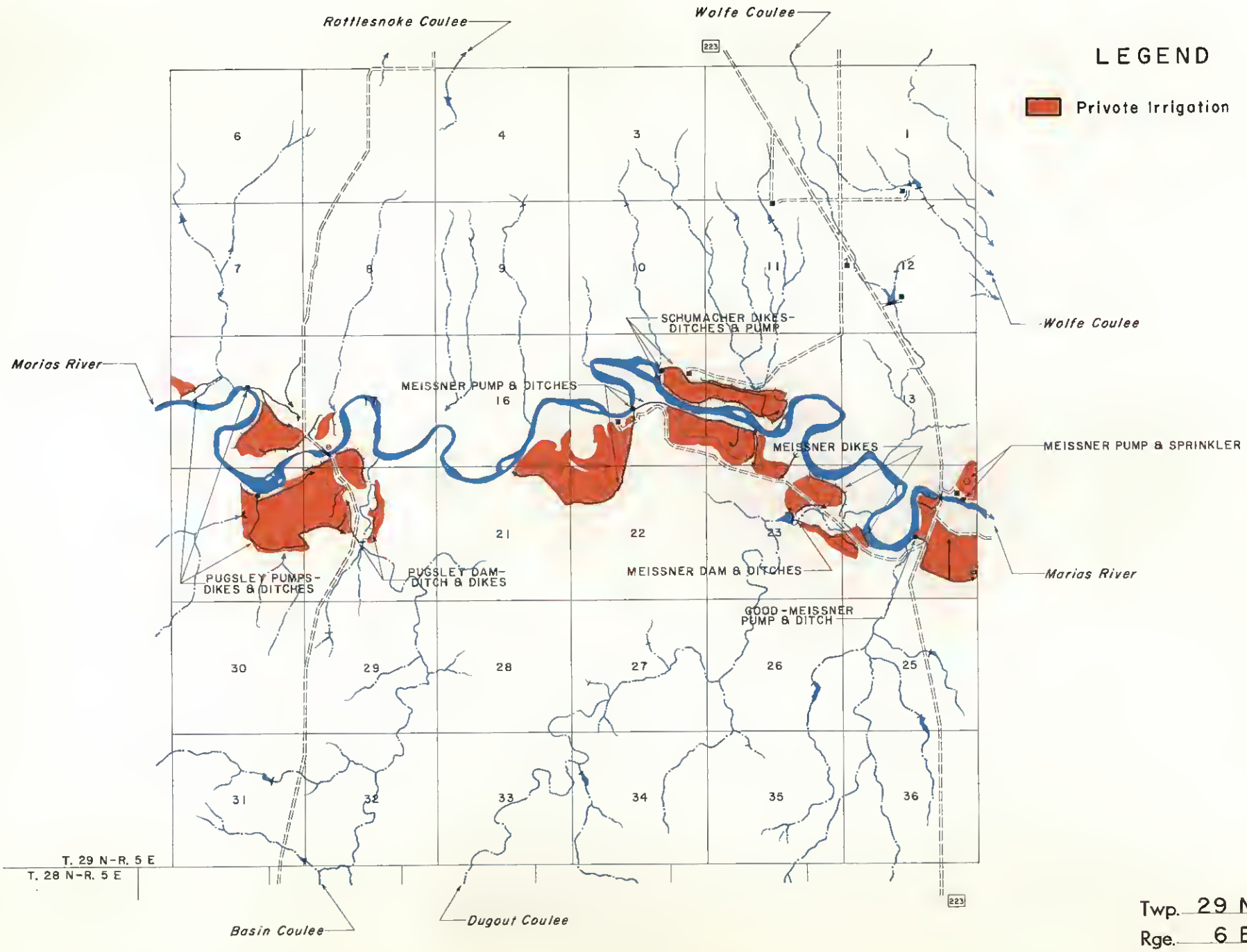


LEGEND

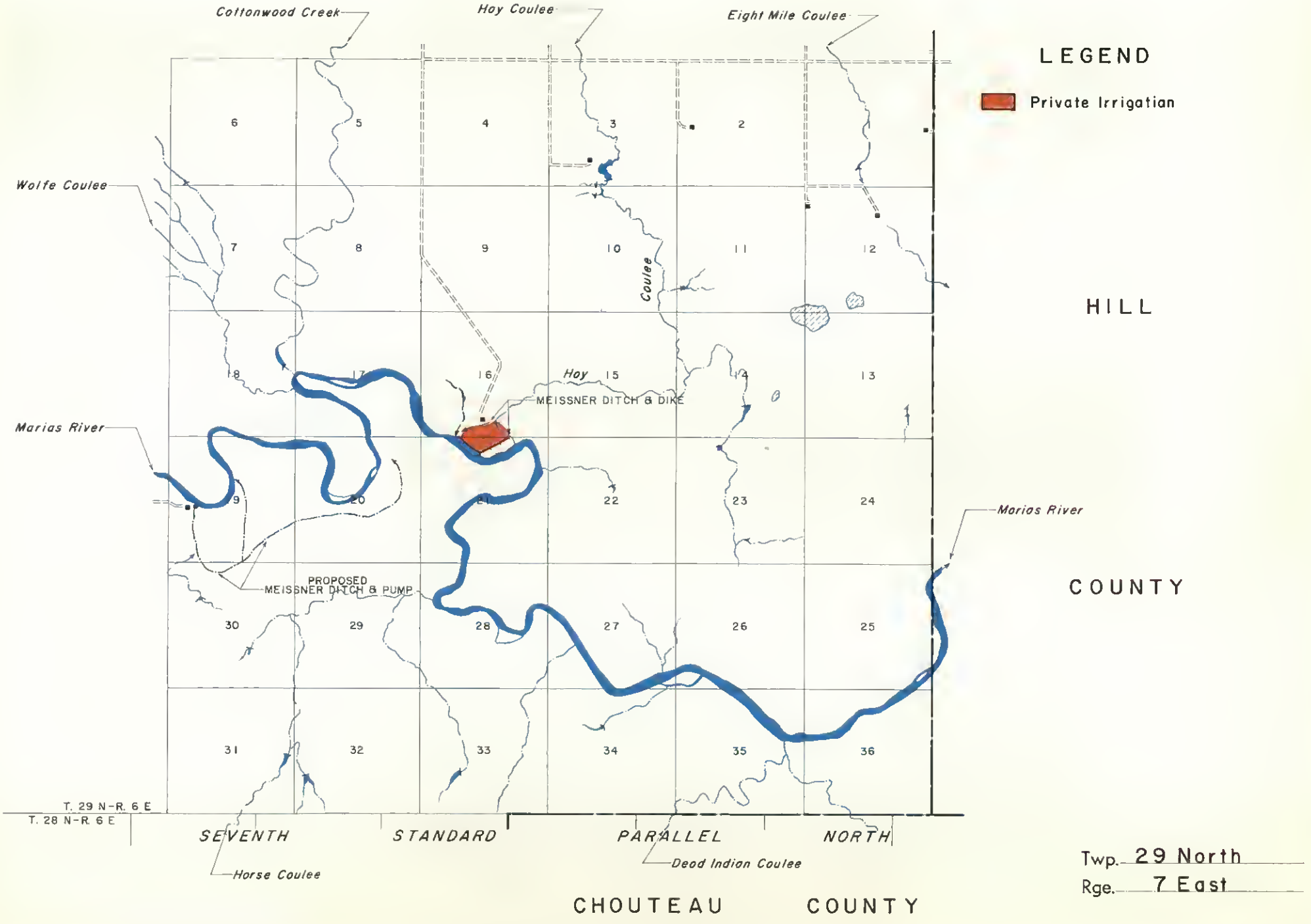
Private Irrigation

Twp. 29 North

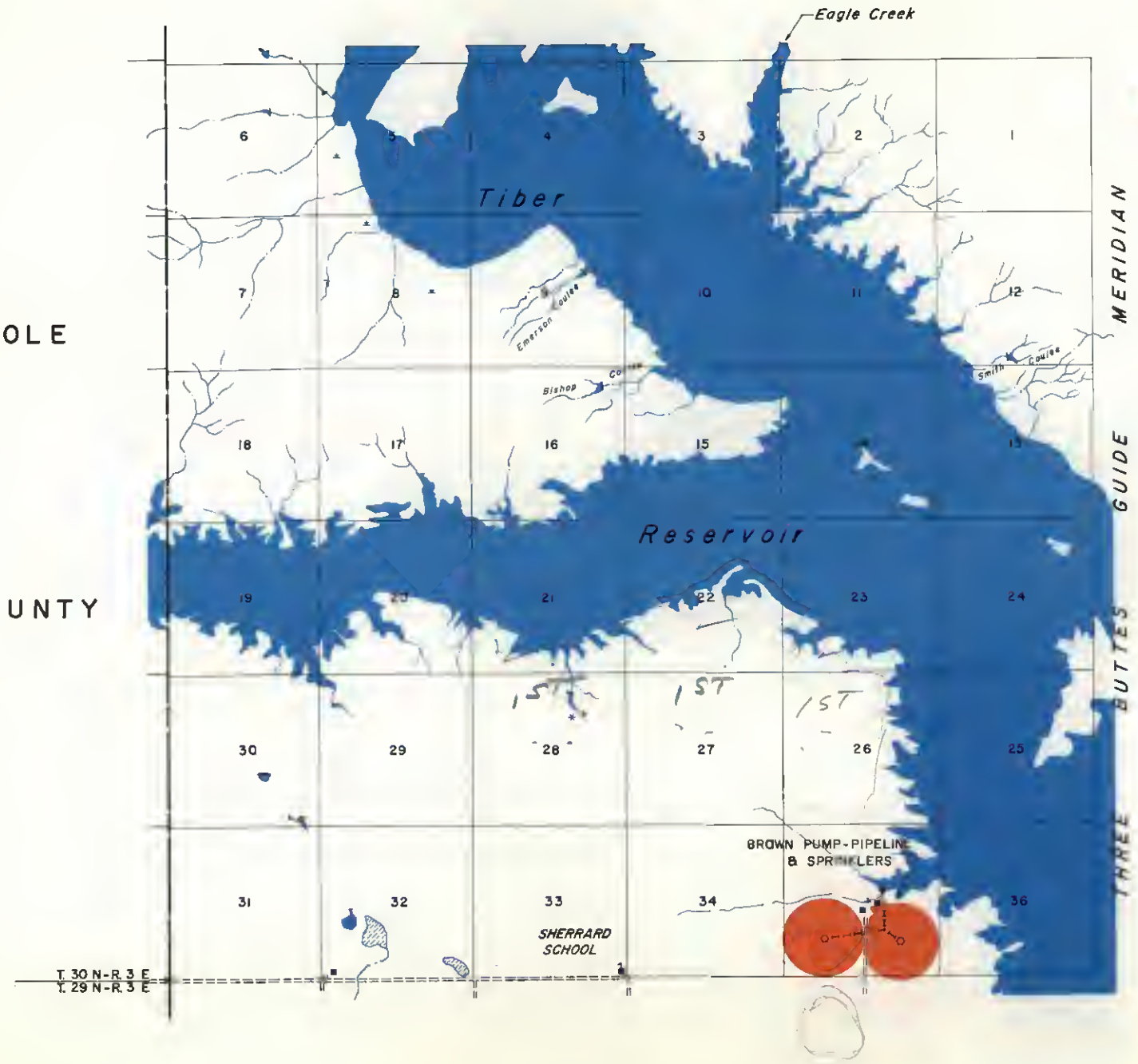
Rge. 5 East



Twp. 29 North
Rge. 6 East



Twp. 29 North
Rge. 7 East



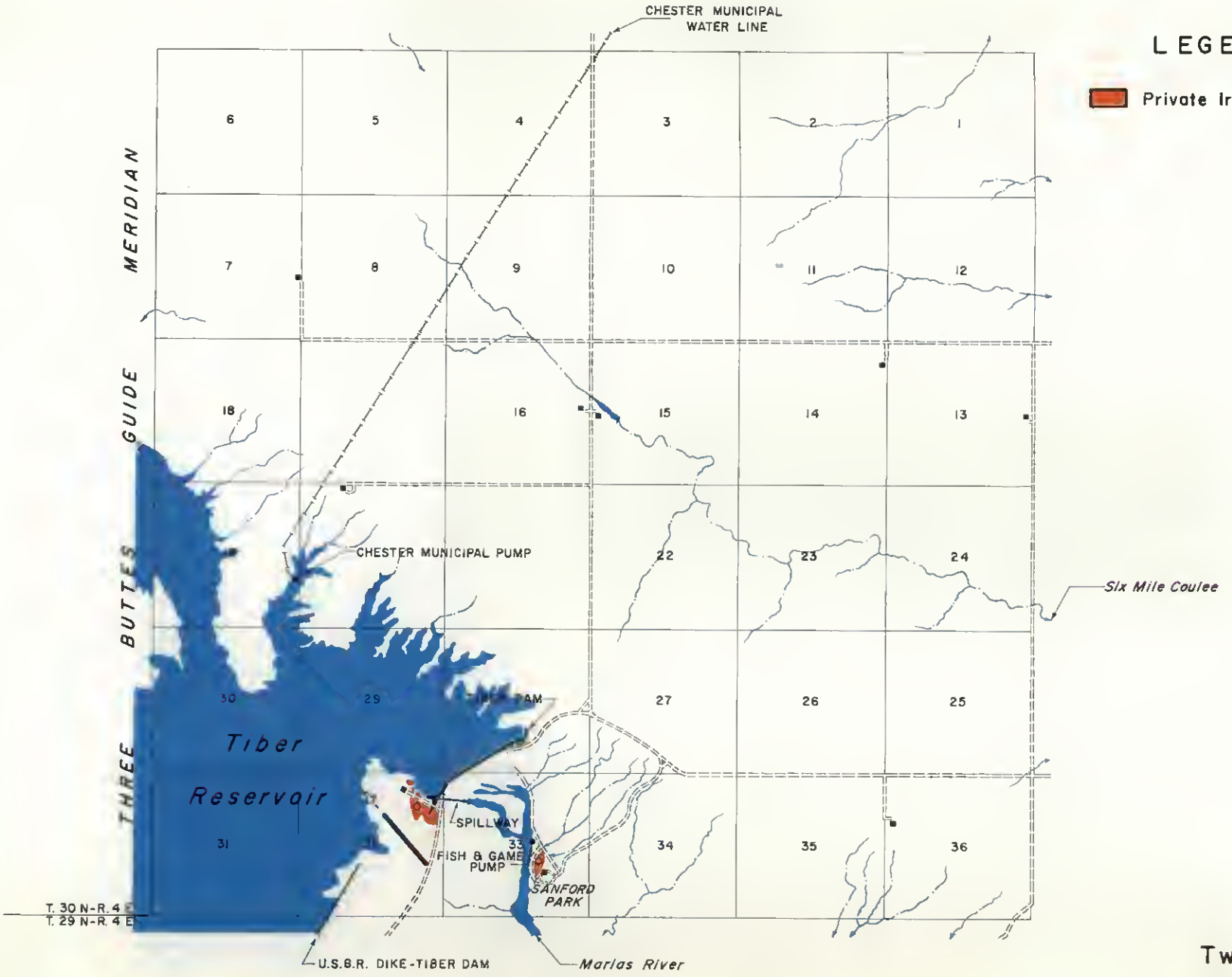
TOOLE COUNTY

LEGEND

Private Irrigation

Twp. 30 North

Rge. 4 East

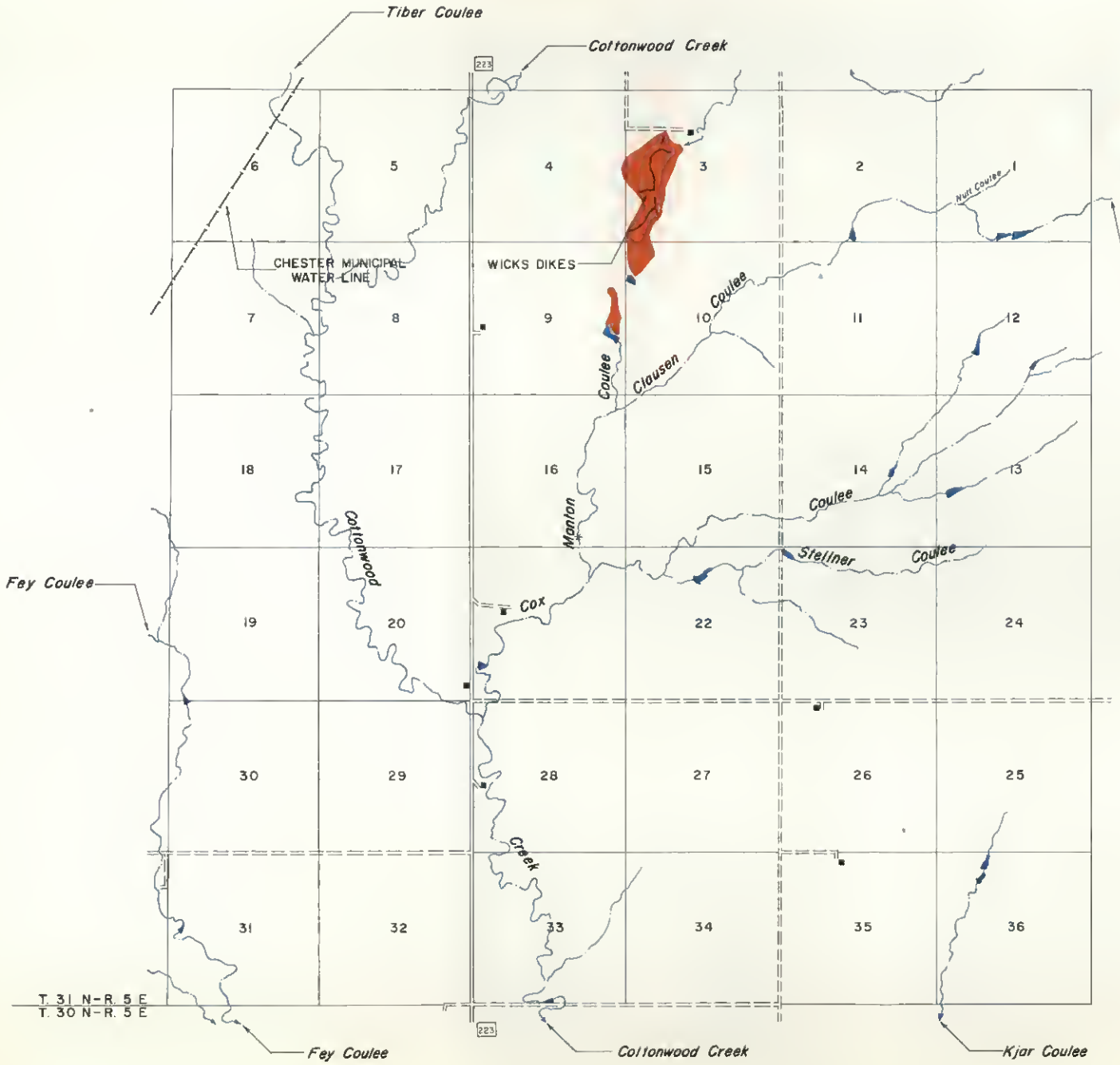


LEGEND

Private Irrigation

Twp. 30 North

Rge. 5 East

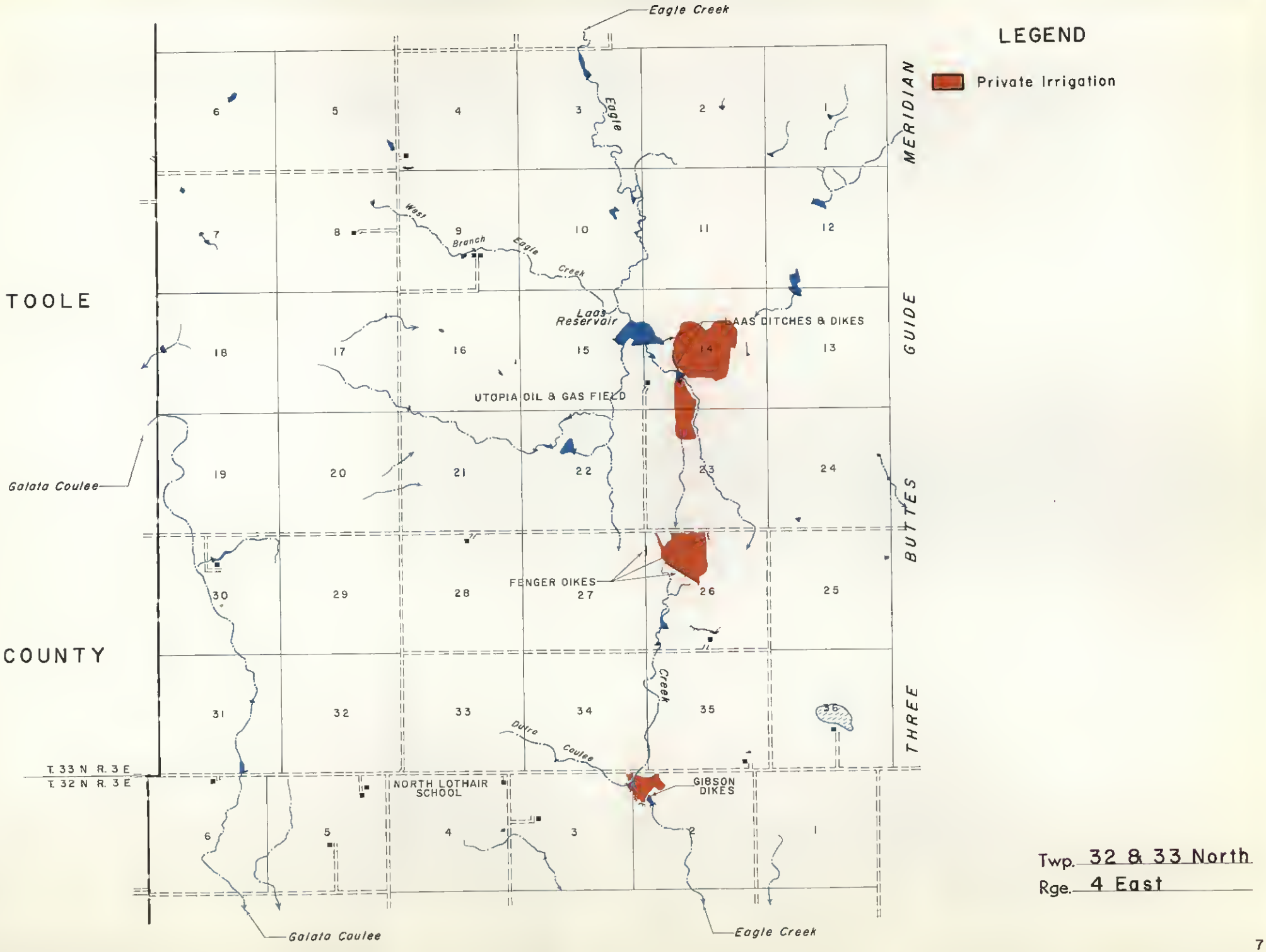


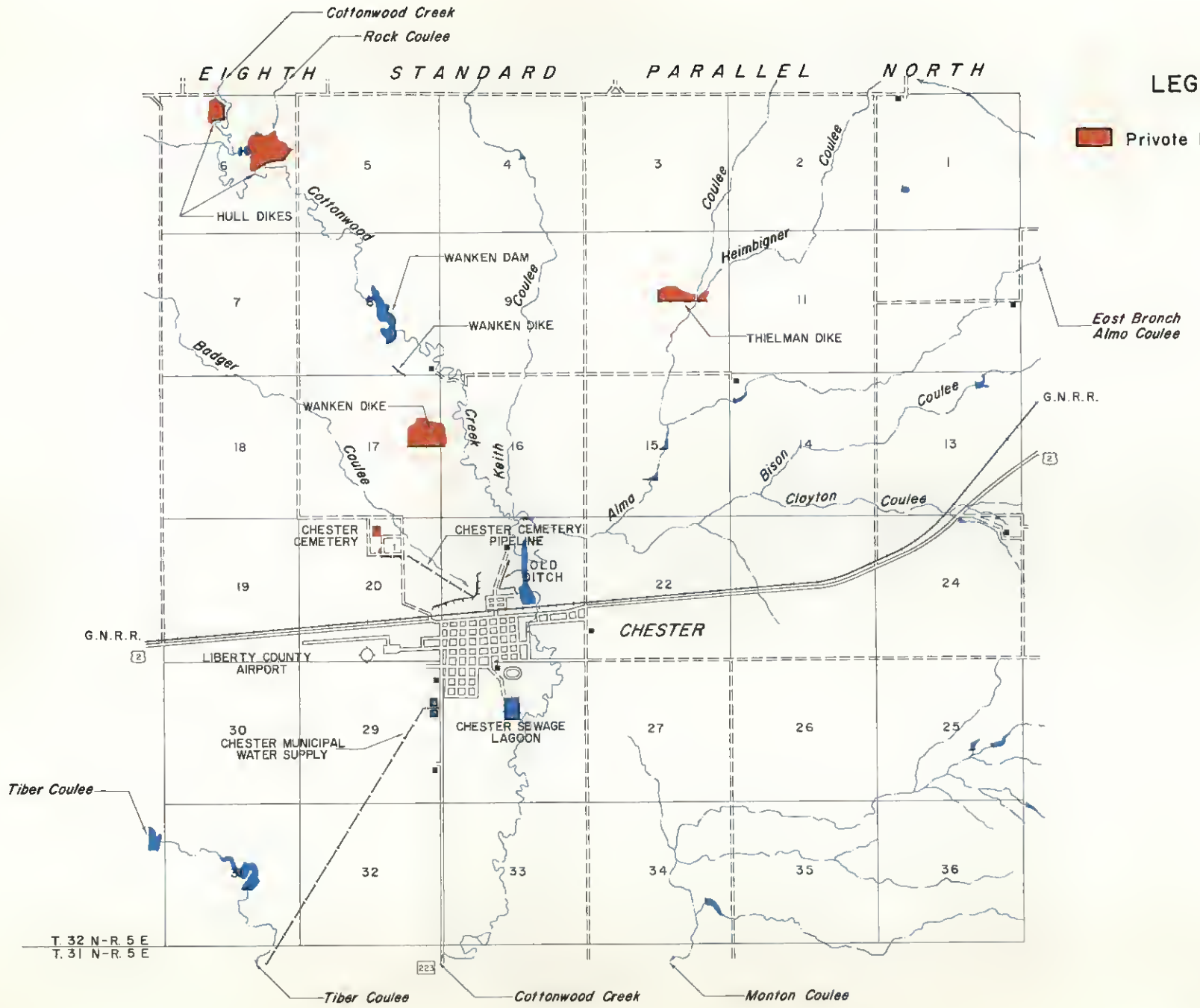
LEGEND

Private Irrigation

Twp. 31 North

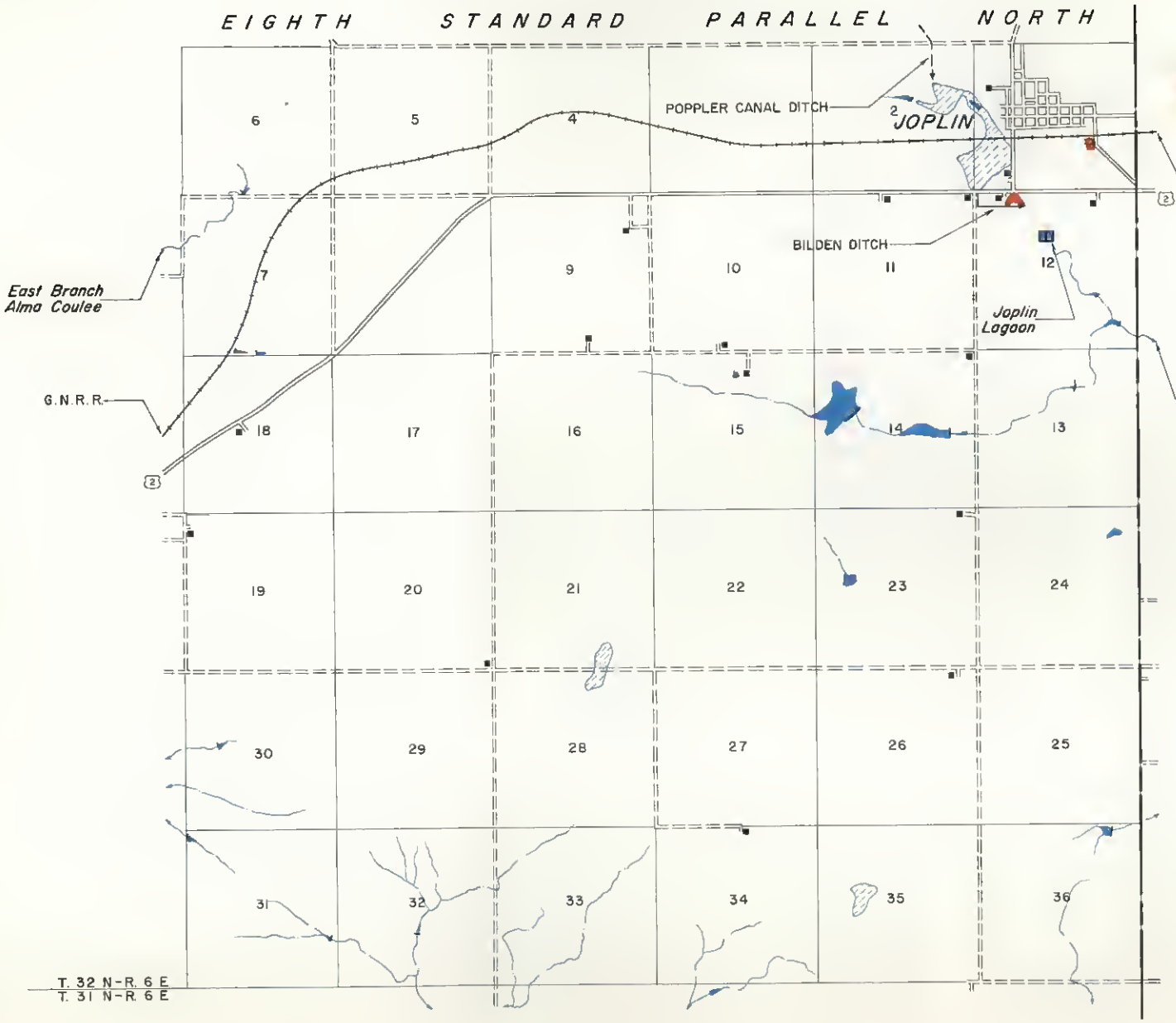
Rge. 6 East


LEGEND
Private Irrigation
Eagle Creek
TOOLE
COUNTY
MERIDIAN
GUIDE
BUTTES
THREE
West Branch Eagle Creek
Laas Reservoir
LAAS DITCHES & DIKES
UTOPIA OIL & GAS FIELD
Galata Coulee
FENGER DIKES
Dutro Coulee
Creek
T. 33 N R. 3 E
T. 32 N R. 3 E
NORTH LOTHAIR SCHOOL
GIBSON DIKES
Galata Coulee
Eagle Creek
Twp. 32 & 33 North
Rge. 4 East



Twp. 32 North

Rge. 6 East



LEGEND

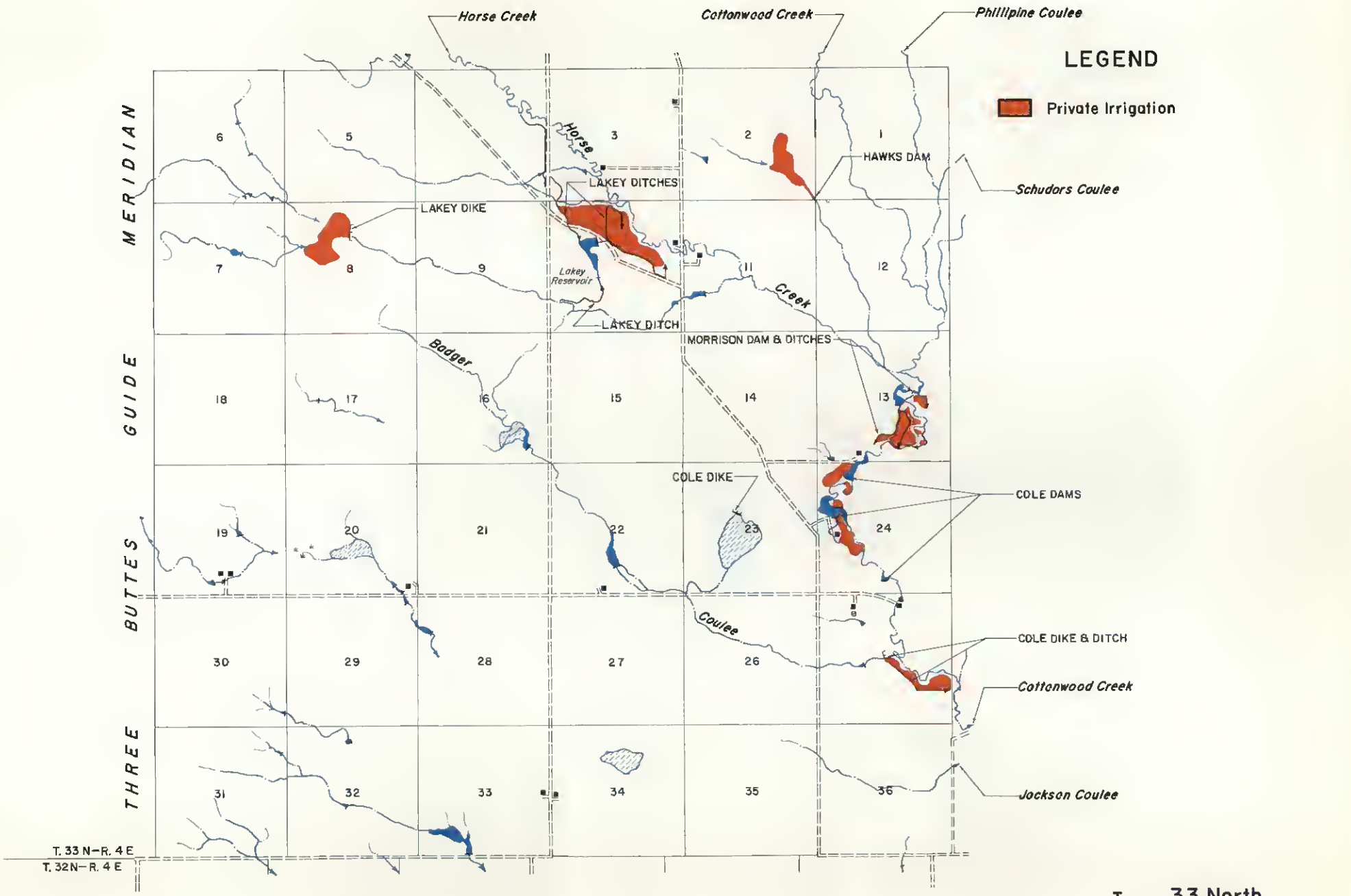
Private Irrigation

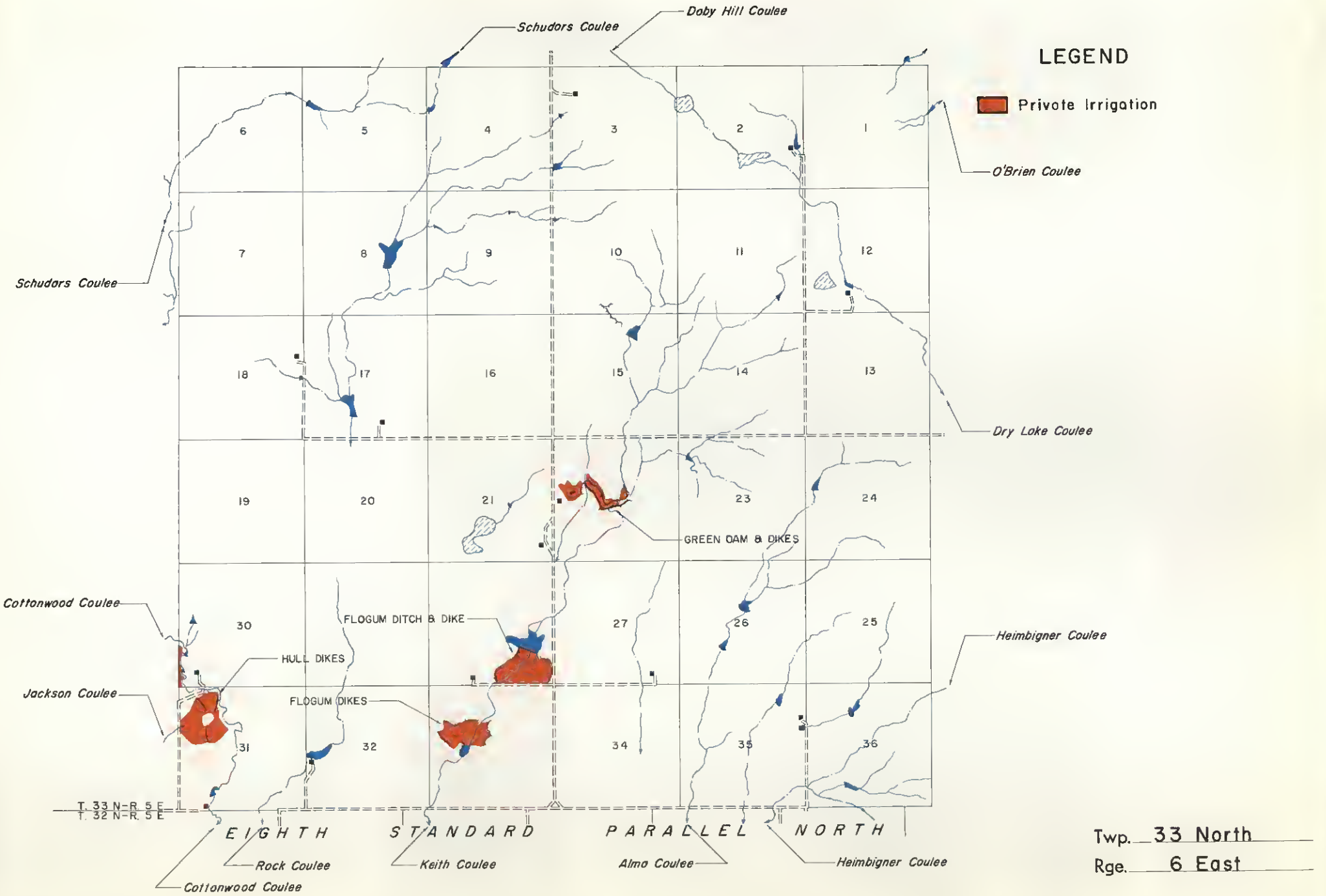
HILL

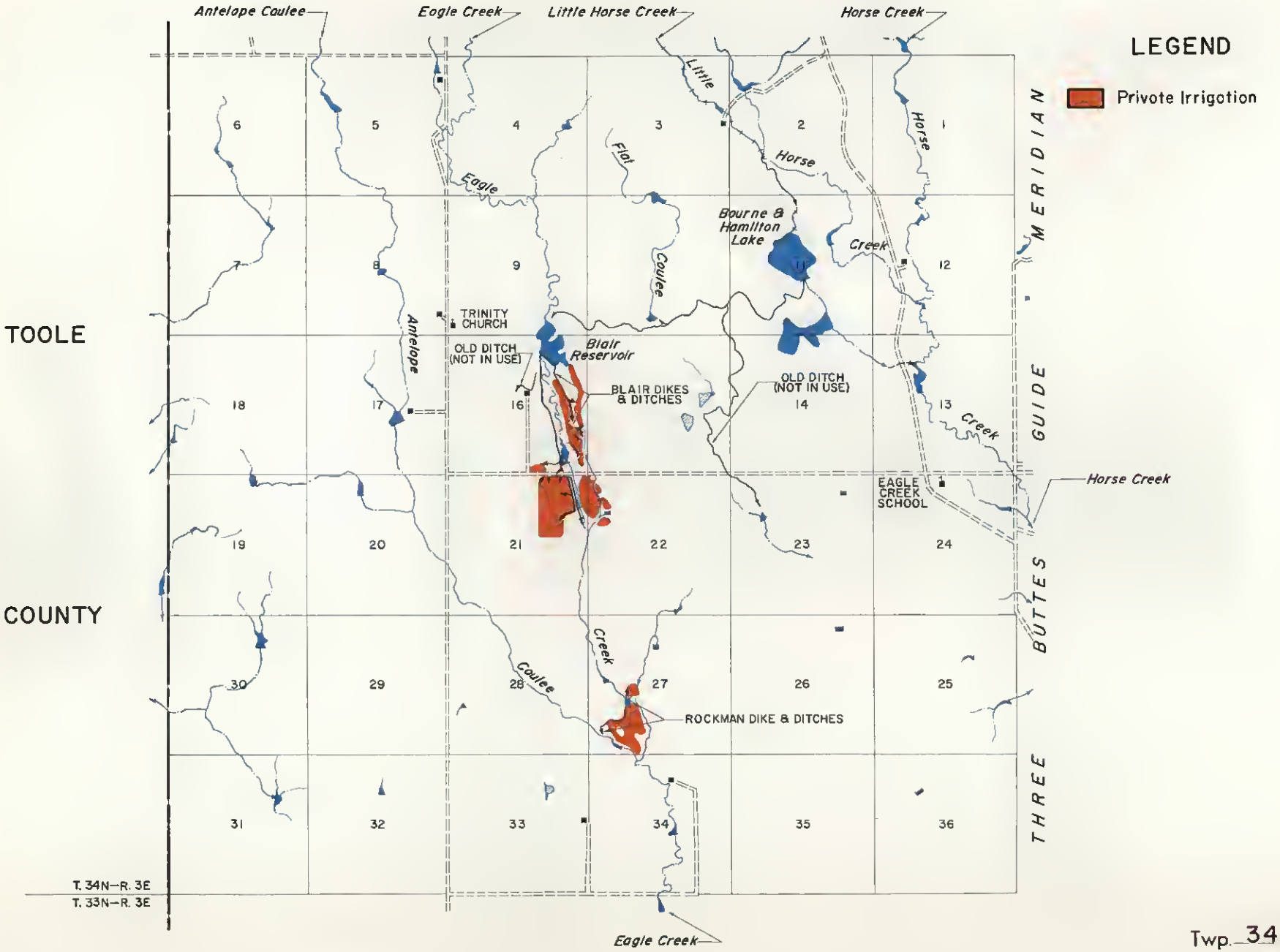
COUNTY

Twp. 32 North

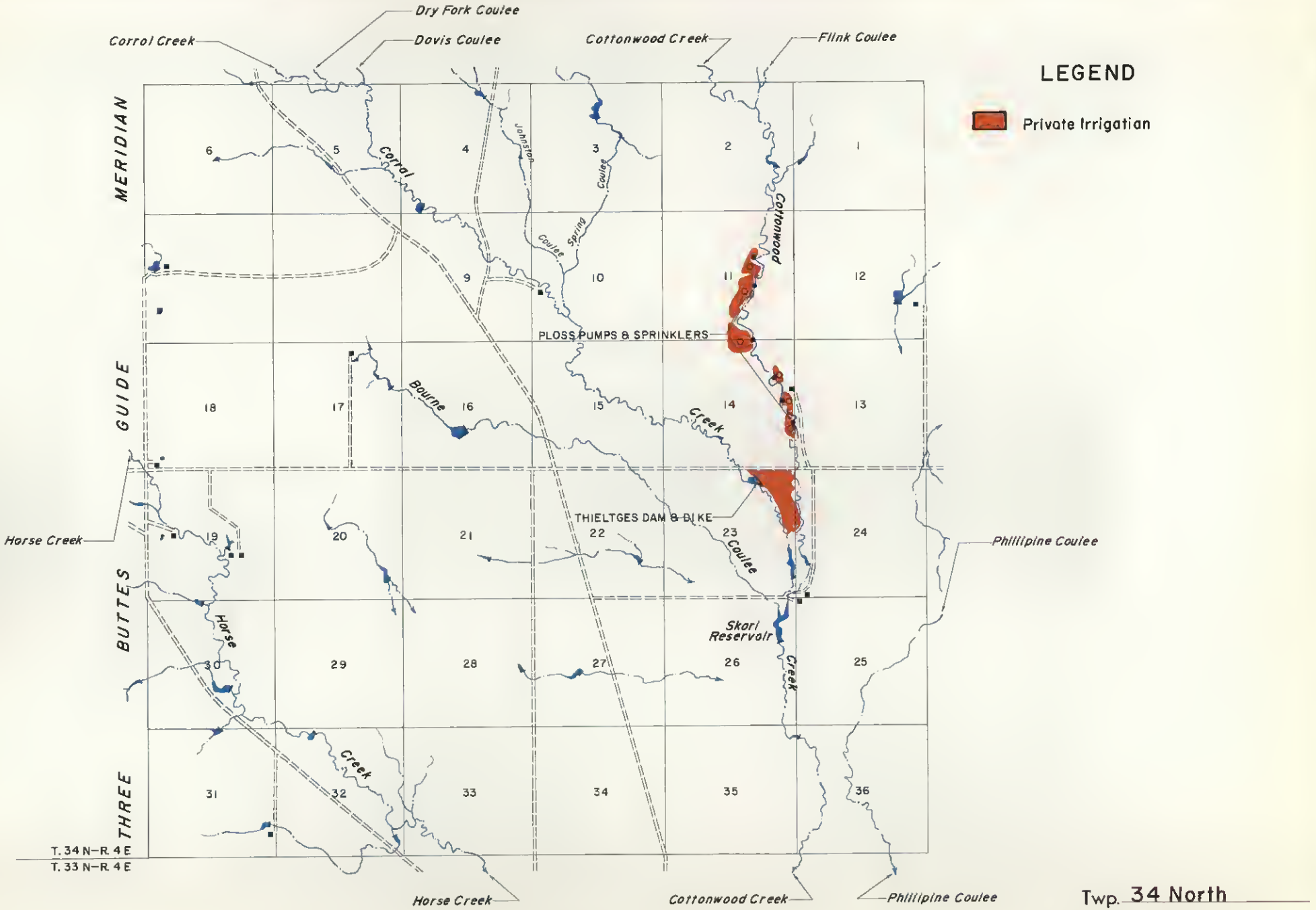
Rge. 7 East

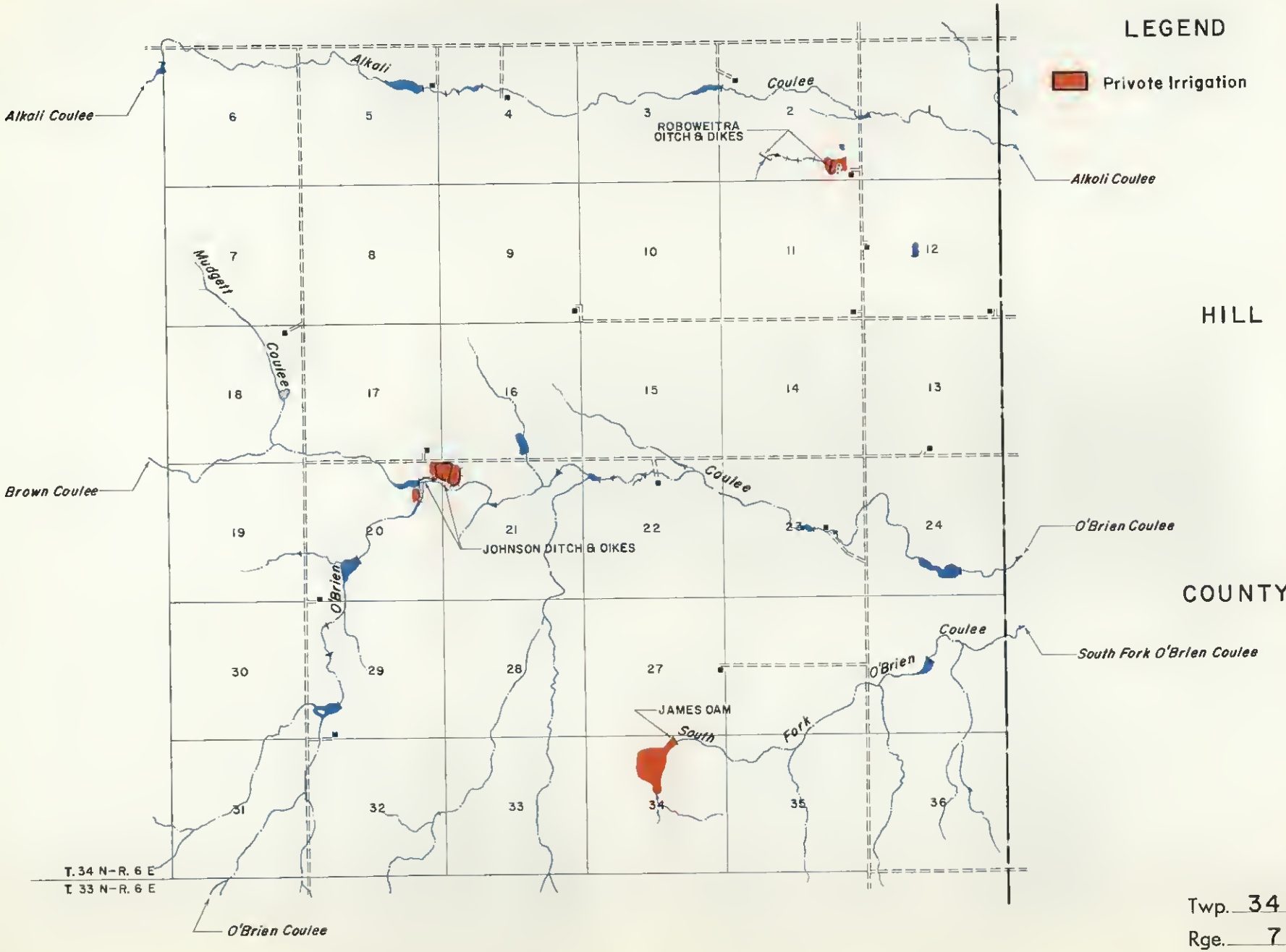

Horse Creek
Cottonwood Creek
Phillipine Coulee
LEGEND
Private Irrigation
HAWKS DAM
Schudors Coulee
LAKEY DITCHES
LAKEY DIKE
Lakey Reservoir
LAKEY DITCH
Creek
MORRISON DAM & DITCHES
Badger
COLE DIKE
COLE DAMS
COLE DIKE & DITCH
Cottonwood Creek
Coulee
Jackson Coulee
MERIDIAN
GUIDE
BUTTES
THREE
T. 33 N–R. 4 E
T. 32N–R. 4 E
Twp. 33 North
Rge. 5 East

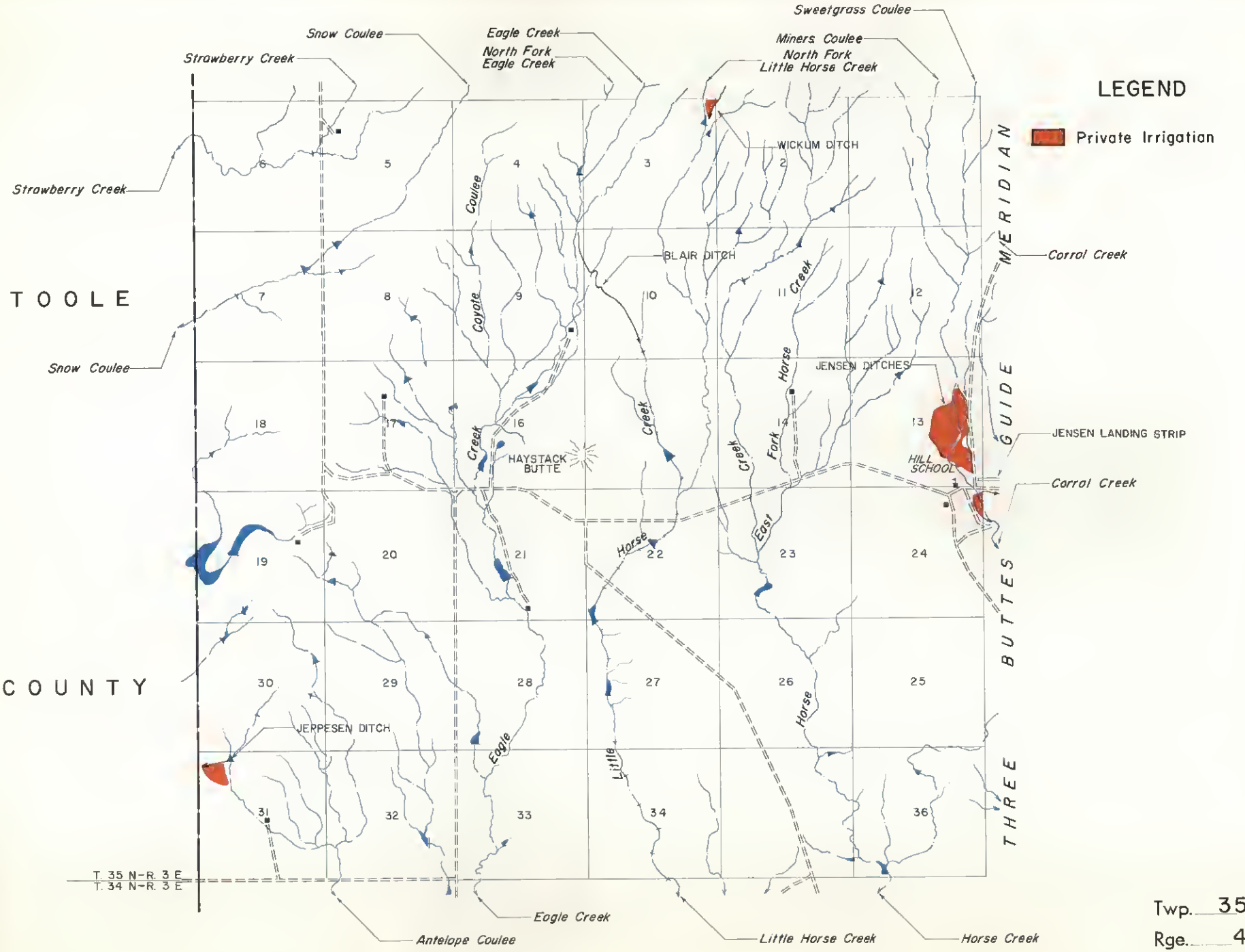

Doby Hill Coulee
Schudors Coulee
LEGEND
Private Irrigation
O'Brien Coulee
Schudors Coulee
Dry Loke Coulee
GREEN DAM & DIKES
Cottonwood Coulee
FLOGUM DITCH & DIKE
HULL DIKES
Jackson Coulee
FLOGUM DIKES
Heimbigner Coulee
T. 33 N-R. 5 E.
T. 32 N-R. 5 E.
EIGHTH STANDARD PARALLEL NORTH
Rock Coulee
Keith Coulee
Almo Coulee
Heimbigner Coulee
Cottonwood Coulee
Twp. 33 North
Rge. 6 East



Twp. 34 North
Rge. 4 East

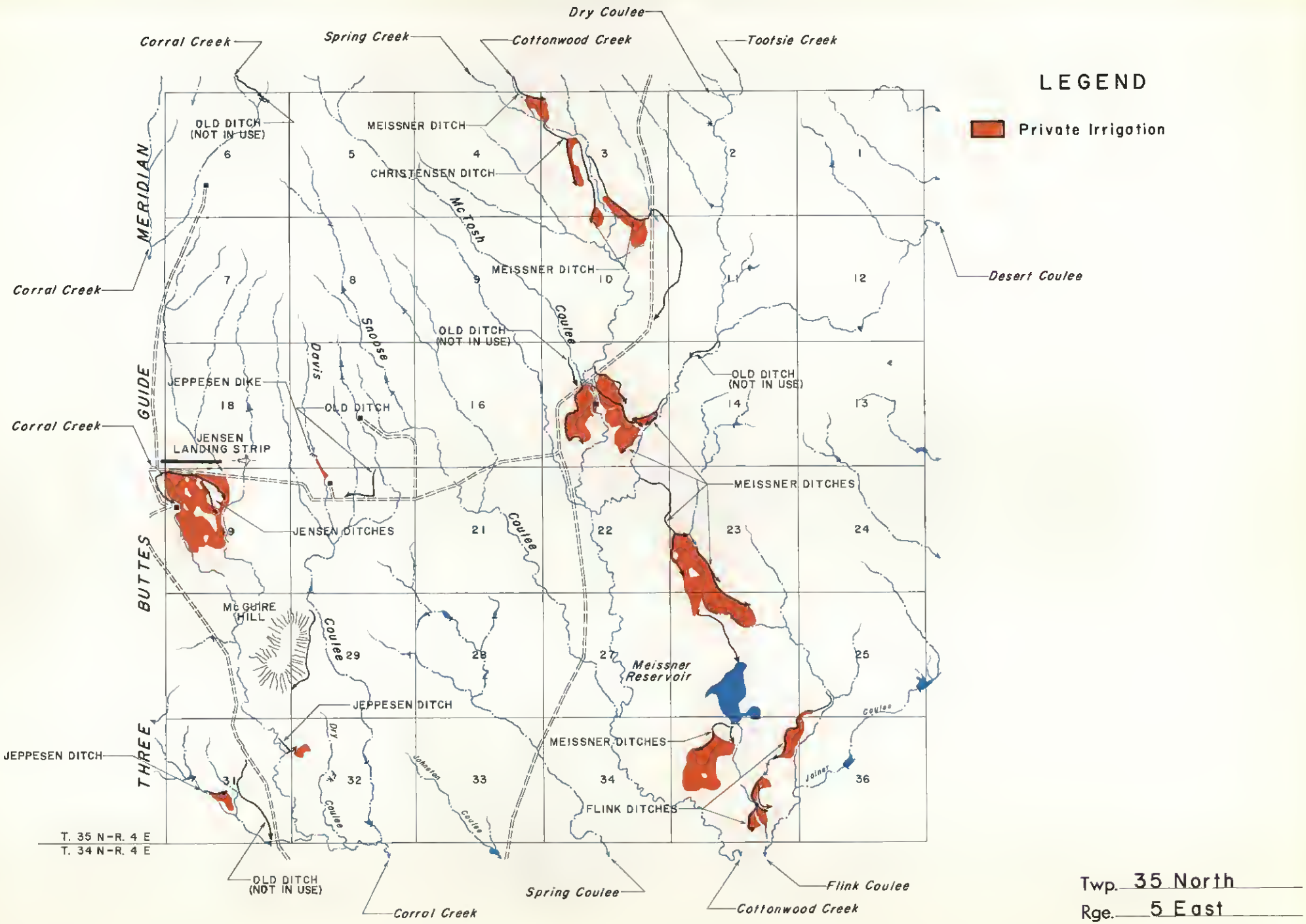

Dry Fork Coulee
Corrol Creek
Dovis Coulee
Cottonwood Creek
Flink Coulee
MERIDIAN
GUIDE
BUTTES
THREE
Corral
Johnston
Coulee
Spring
Coulee
Cottonwood
PLOSS PUMPS & SPRINKLERS
Bourne
Creek
THIELTGES DAM & DIKE
Horse Creek
Coulee
Phillipine Coulee
Skori Reservoir
Horse
Creek
Creek
Horse Creek
Cottonwood Creek
Phillipine Coulee
T. 34 N–R. 4 E
T. 33 N–R. 4 E
LEGEND
Private Irrigation
Twp. 34 North
Rge. 5 East


LEGEND
Private Irrigation
HILL
COUNTY
Alkali Coulee
Alkali
Coulee
ROBOWEITRA DITCH & DIKES
Alkoli Coulee
Mudgett
Coulee
Brown Coulee
Coulee
O'Brien Coulee
JOHNSON DITCH & DIKES
O'Brien
Coulee
South Fork O'Brien Coulee
O'Brien
JAMES DAM
South
Fork
T. 34 N-R. 6 E
T. 33 N-R. 6 E
O'Brien Coulee
Twp. 34 North
Rge. 7 East



Twp. 35 North

Rge. 4 East

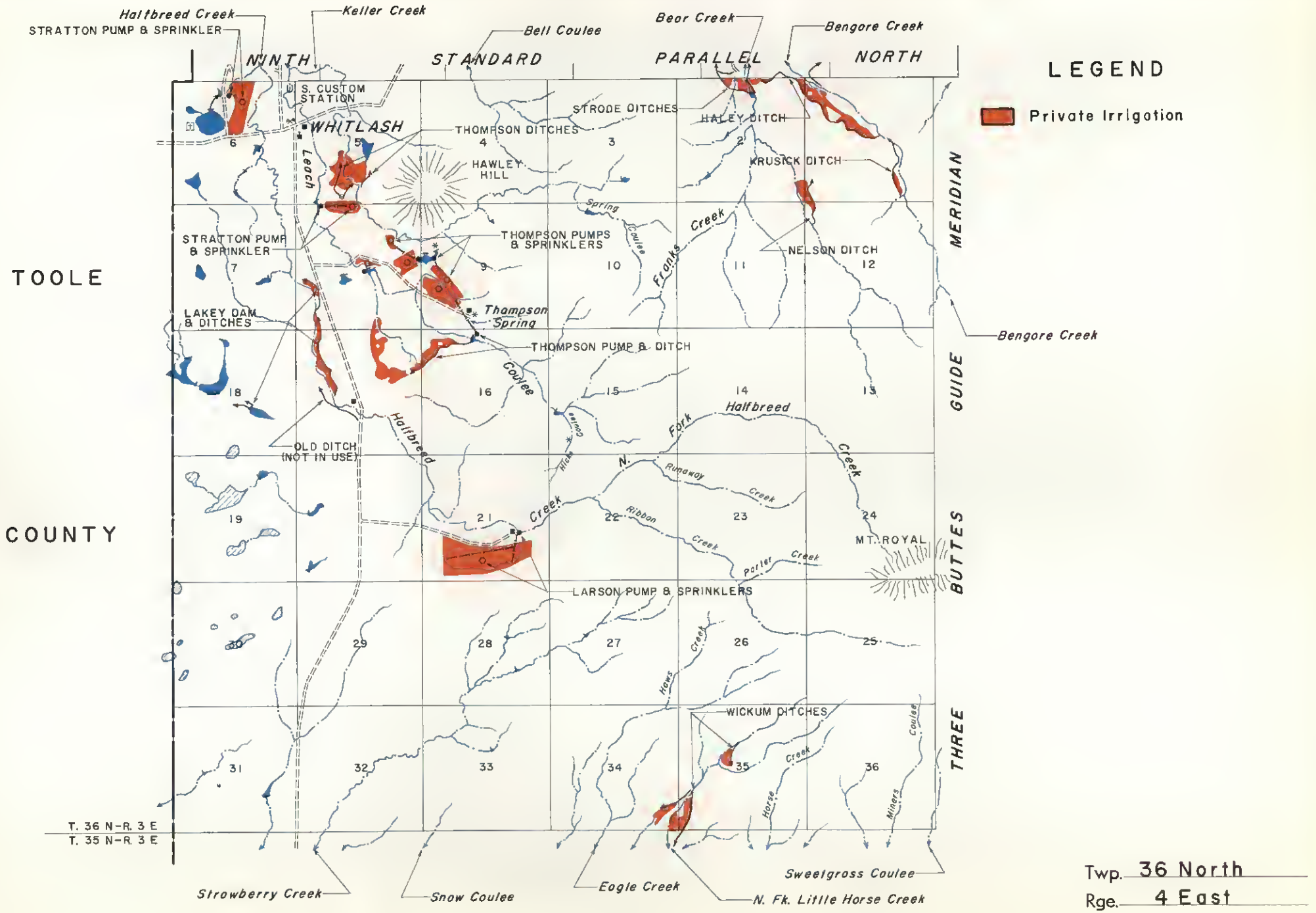


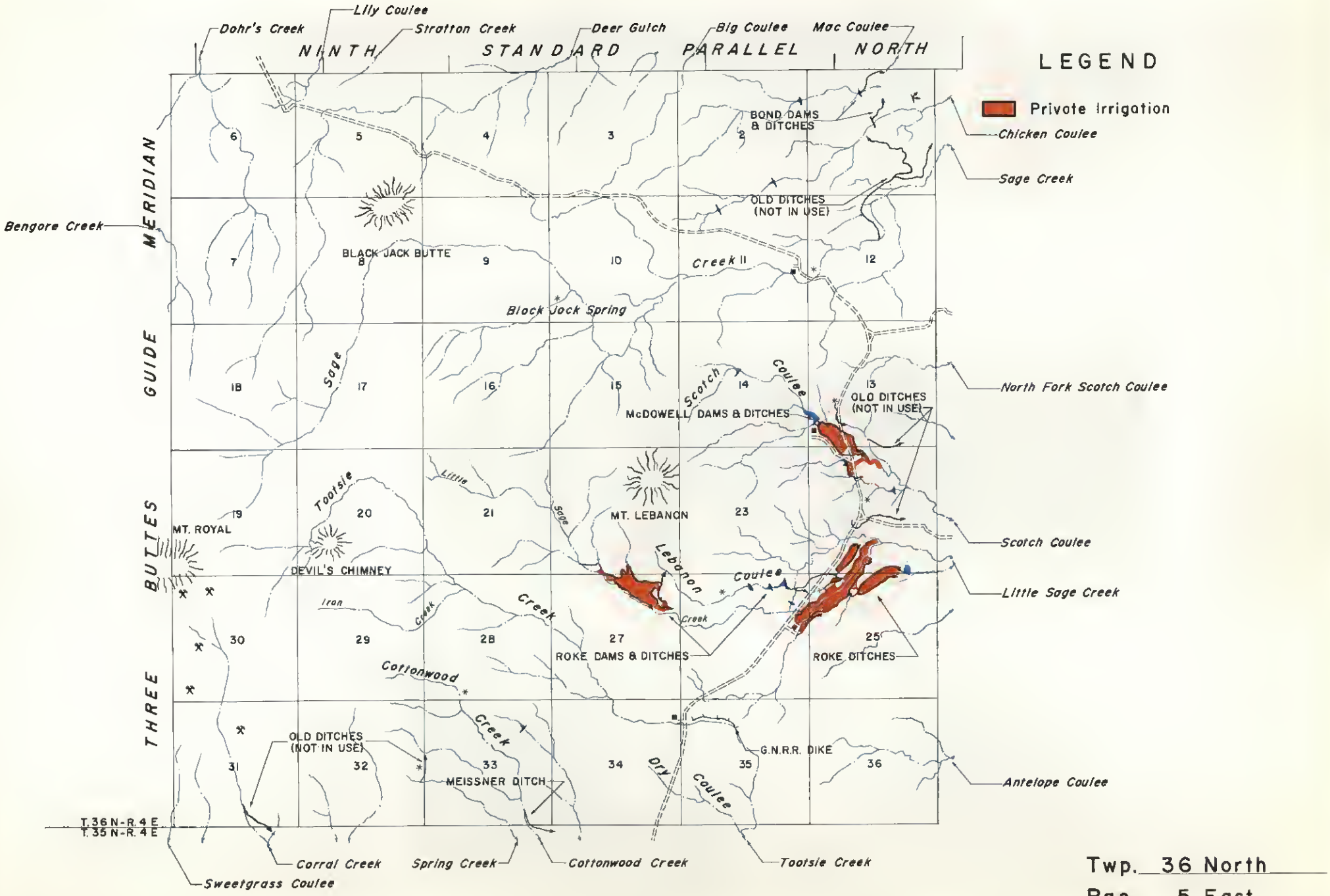
LEGEND

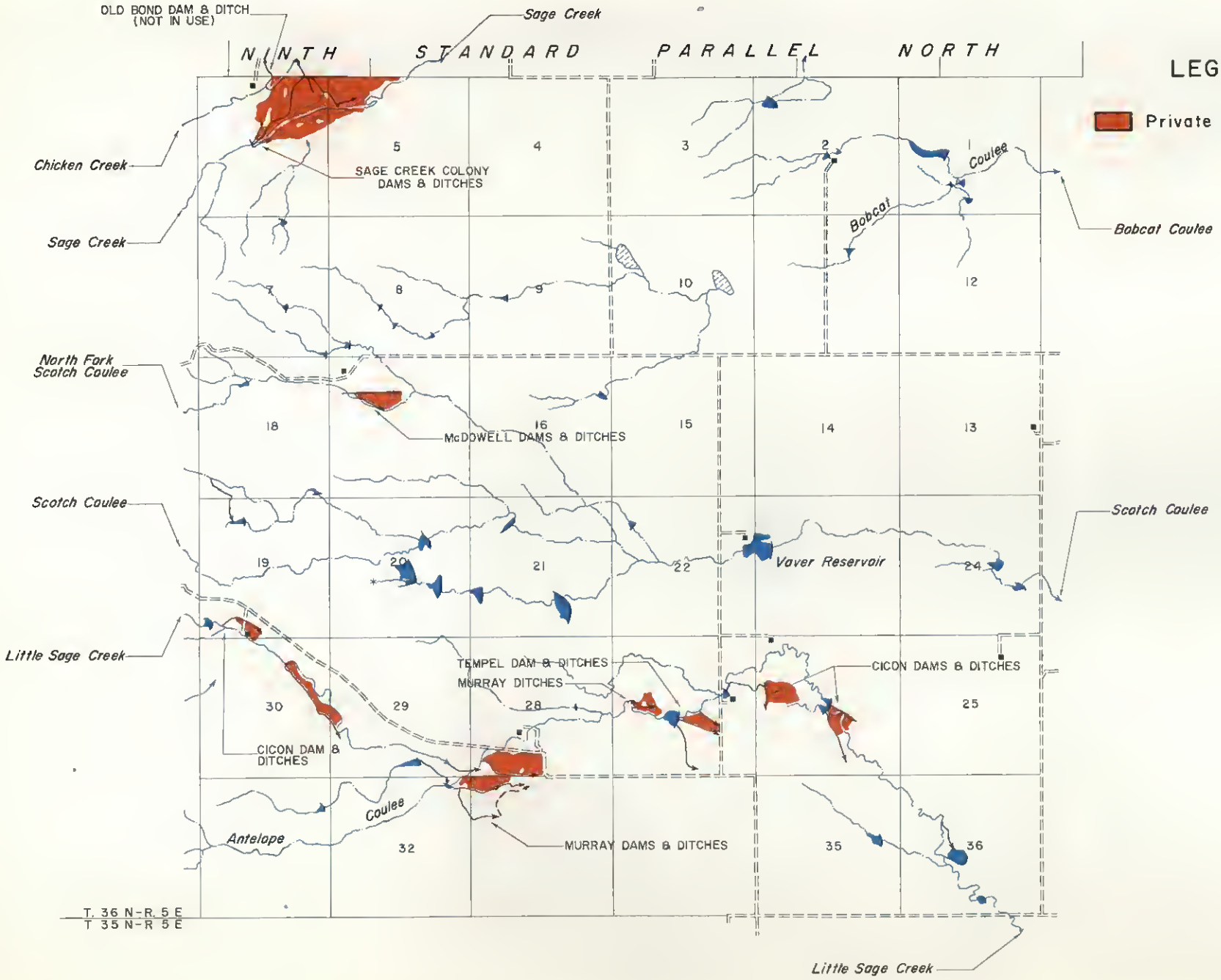
Private Irrigation

Twp. 35 North

Rge. 5 East


Halfbreed Creek
STRATTON PUMP & SPRINKLER
Keller Creek
Bell Coulee
Beor Creek
Bengore Creek
NINTH
STANDARD
PARALLEL
NORTH
LEGEND
Private Irrigation
U.S. CUSTOM STATION
WHITLASH
Leach
THOMPSON DITCHES
STRODE DITCHES
HALEY DITCH
KRUSICK DITCH
HAWLEY HILL
Spring Coulee
Franks Creek
NELSON DITCH
STRATTON PUMP & SPRINKLER
THOMPSON PUMPS & SPRINKLERS
LAKEY DAM & DITCHES
Thompson Spring
THOMPSON PUMP & DITCH
Bengore Creek
Coulee
Halfbreed Fork
Halfbreed Creek
OLD DITCH (NOT IN USE)
Hicks Coulee
N. Runaway Creek
Ribbon Creek
MT. ROYAL
Porter Creek
LARSON PUMP & SPRINKLERS
Haws Creek
WICKUM DITCHES
Horse Creek
Miners Coulee
TOOLE COUNTY
MERIDIAN
GUIDE
BUTTES
THREE
T. 36 N-R. 3 E
T. 35 N-R. 3 E
Strowberry Creek
Snow Coulee
Eagle Creek
N. Fk. Little Horse Creek
Sweetgross Coulee
Twp. 36 North
Rge. 4 East


Lily Coulee
Dohr's Creek
Stratton Creek
Deer Gulch
Big Coulee
Mac Coulee
NINTH STANDARD PARALLEL NORTH
BOND DAMS & DITCHES
Chicken Coulee
Sage Creek
OLD DITCHES (NOT IN USE)
Bengore Creek
BLACK JACK BUTTE
Creek
Block Jock Spring
Sage
Scotch
Coulee
North Fork Scotch Coulee
McDOWELL DAMS & DITCHES
OLD DITCHES (NOT IN USE)
Tootsie
Little
MT. LEBANON
MT. ROYAL
DEVIL'S CHIMNEY
Scotch Coulee
Lebanon
Coulee
Little Sage Creek
Iron
Creek
Cottonwood
ROKE DAMS & DITCHES
ROKE DITCHES
OLD DITCHES (NOT IN USE)
G.N.R.R. DIKE
MEISSNER DITCH
Dry
Coulee
Antelope Coulee
MERIDIAN
GUIDE
BUTTES
THREE
T.36N-R.4E
T.35N-R.4E
Sweetgrass Coulee
Corral Creek
Spring Creek
Cottonwood Creek
Tootsie Creek
LEGEND
Private Irrigation
Twp. 36 North
Rge. 5 East

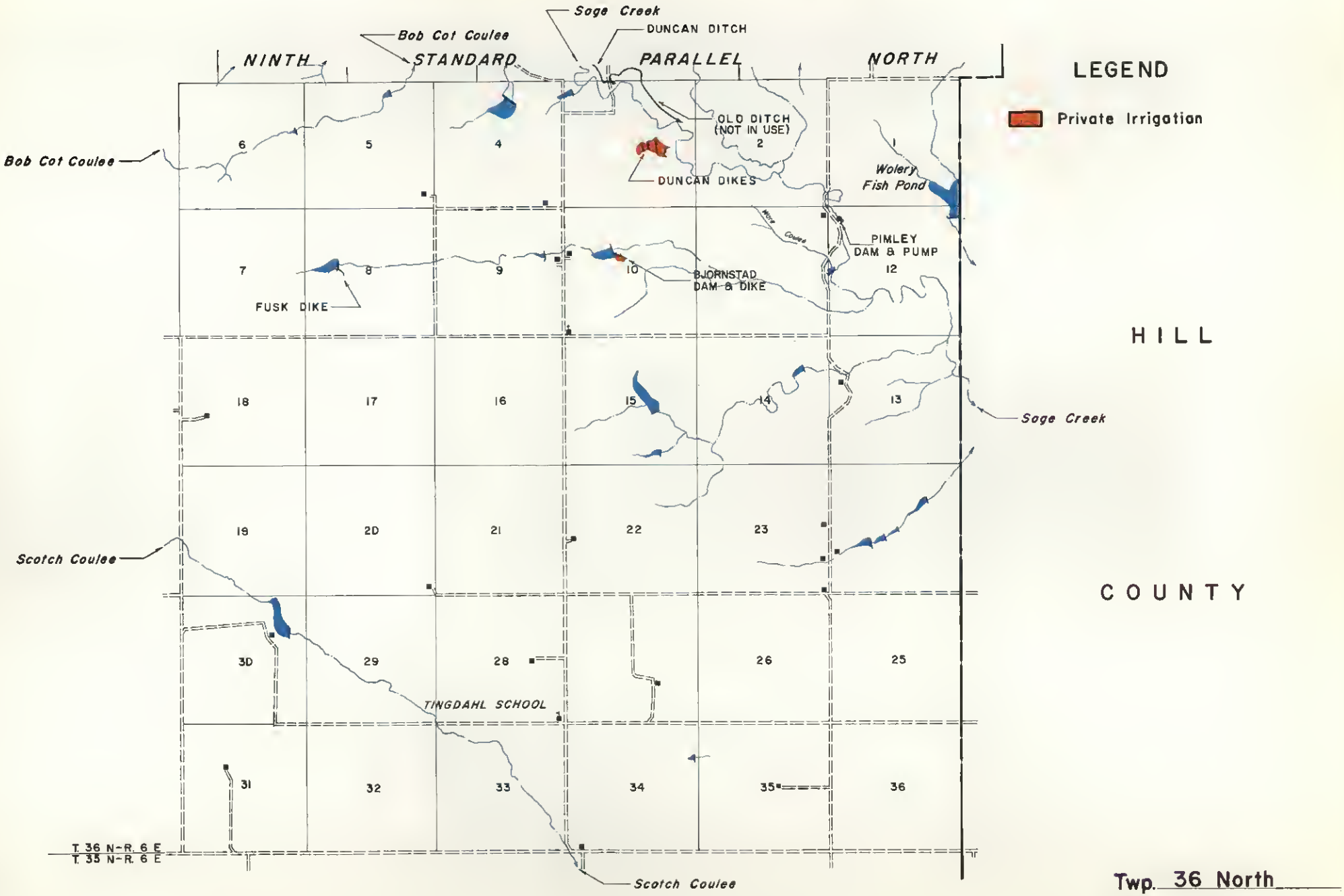


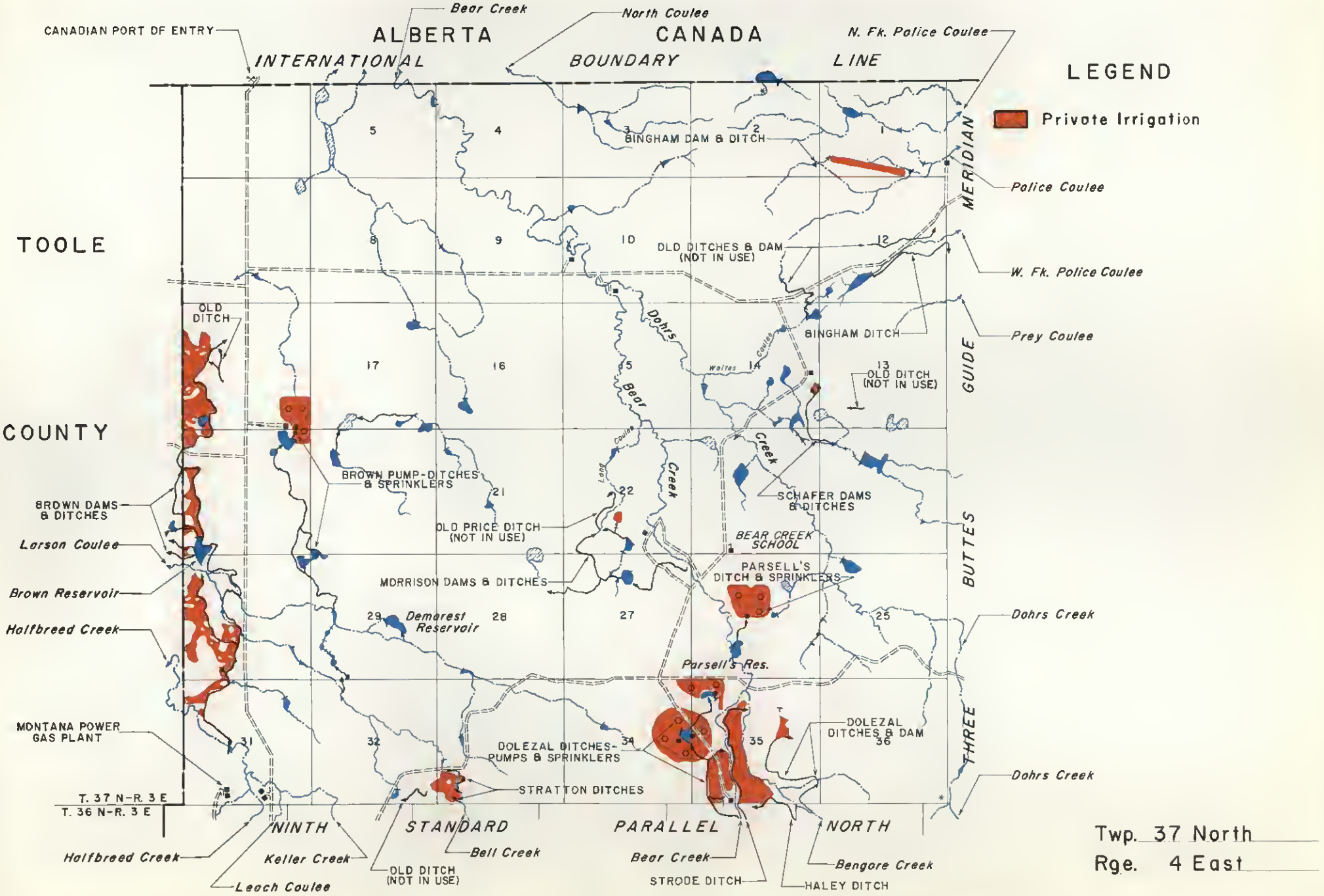
LEGEND

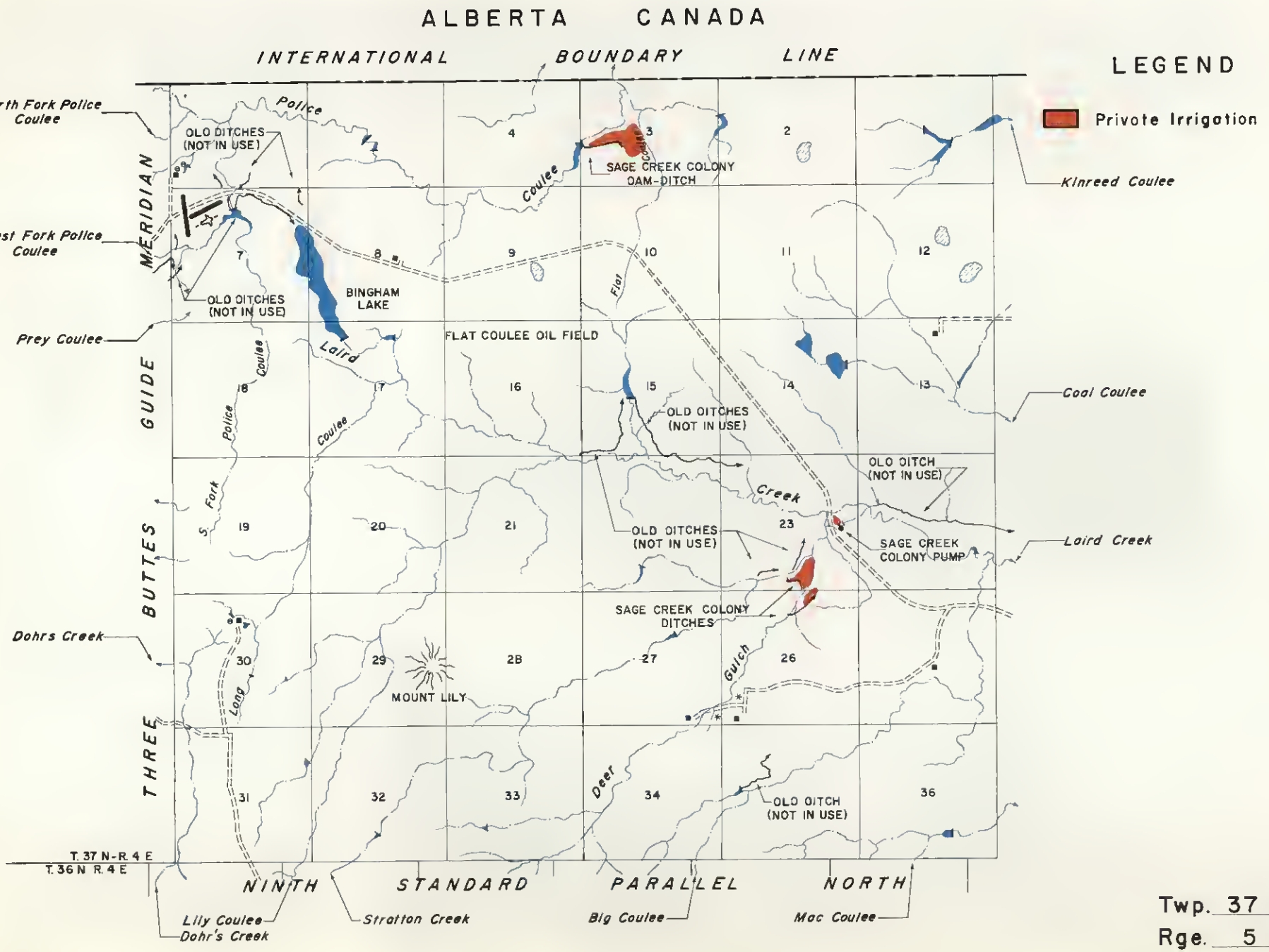
Private Irrigation

Twp. 36 North

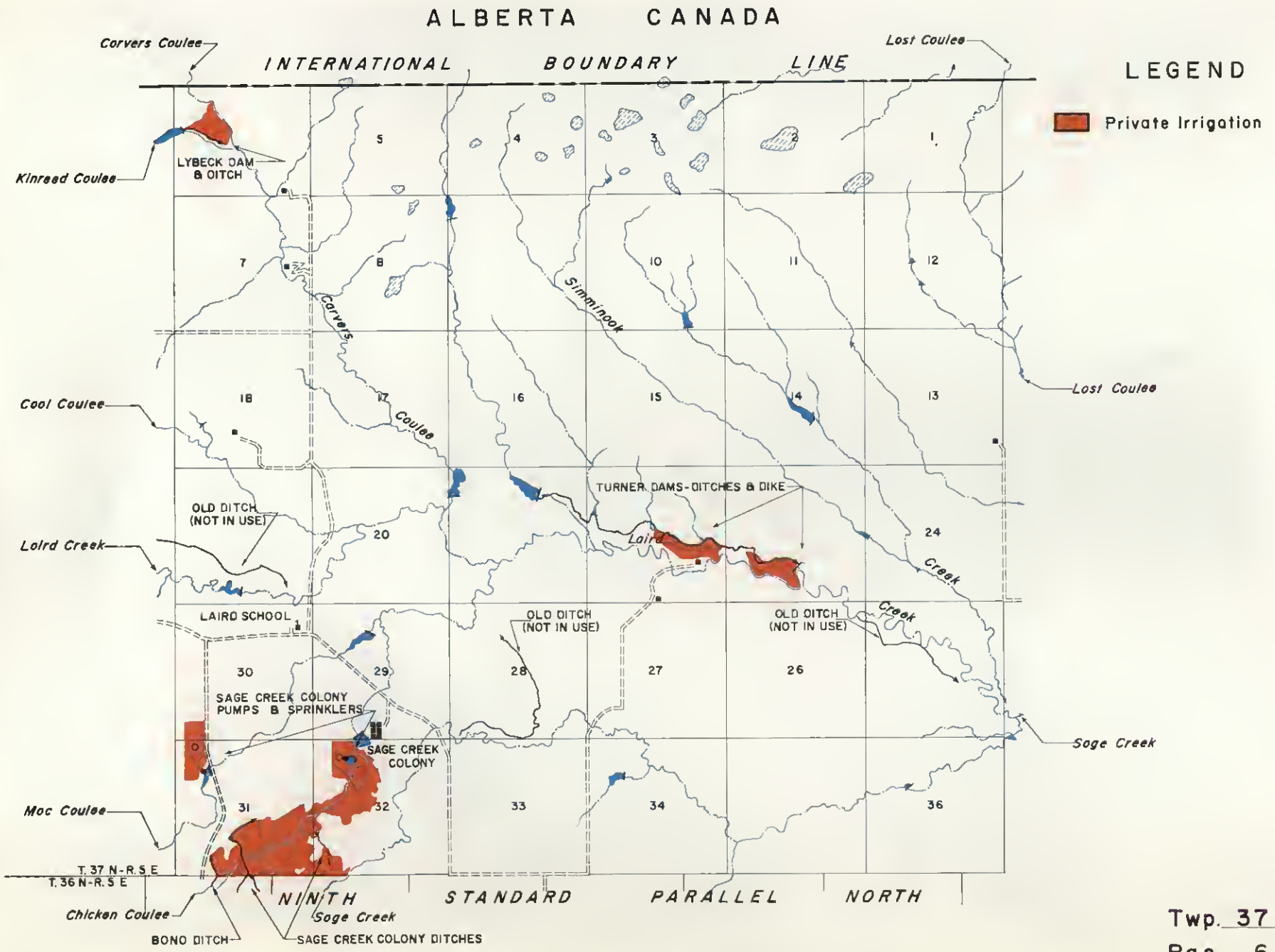
Rge. 6 East

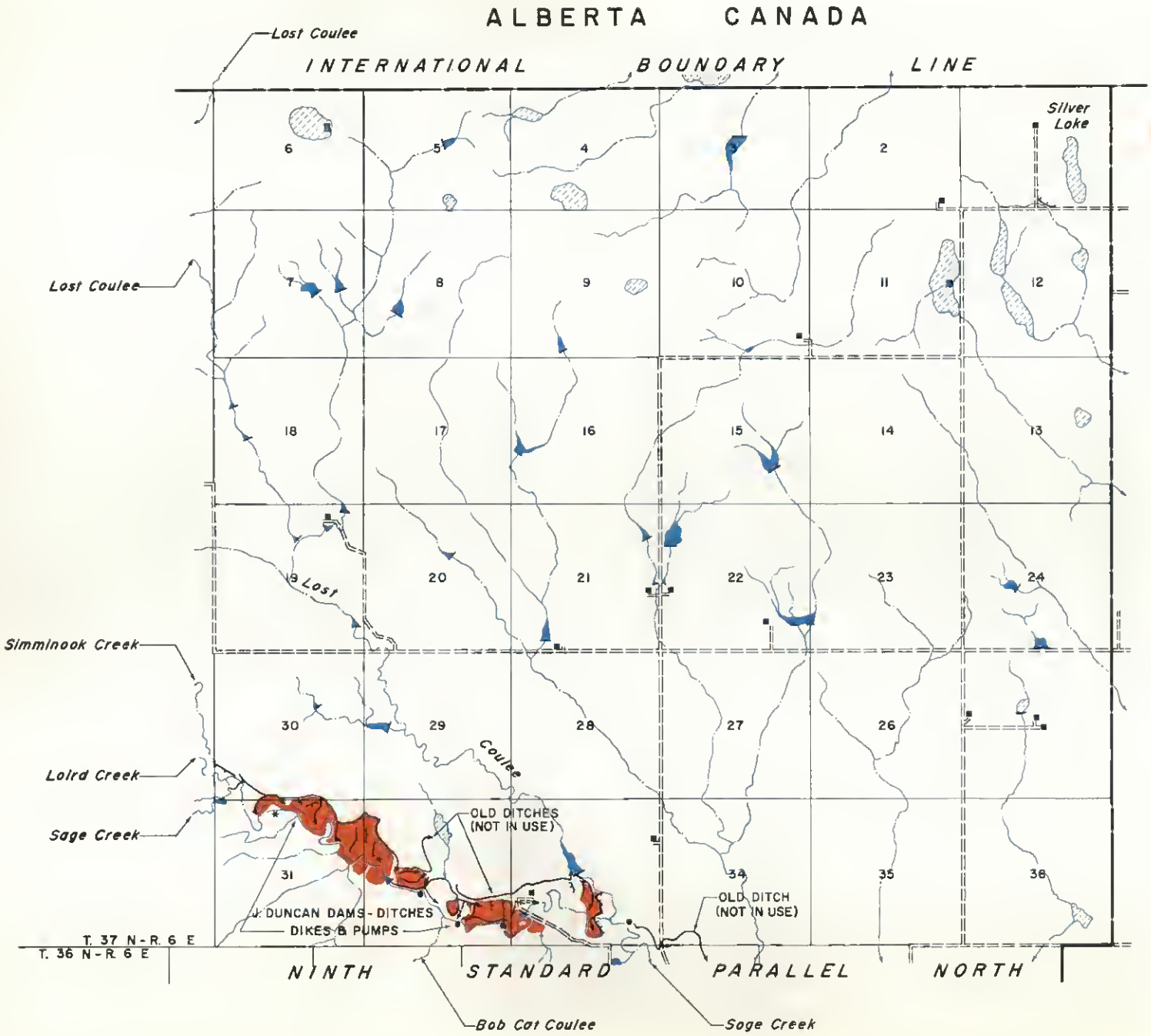

Soge Creek
DUNCAN DITCH
Bob Cot Coulee
NINTH
STANDARD
PARALLEL
NORTH
OLD DITCH (NOT IN USE)
DUNCAN DIKES
Wolery Fish Pond
Bob Cot Coulee
PIMLEY DAM & PUMP
BJORNSTAD DAM & DIKE
FUSK DIKE
HILL
Soge Creek
Scotch Coulee
COUNTY
TINGDAHL SCHOOL
T. 36 N.-R. 6 E.
T. 35 N.-R. 6 E.
Scotch Coulee
LEGEND
Private Irrigation
Twp. 36 North
Rge. 7 East


CANADIAN PORT OF ENTRY
INTERNATIONAL BOUNDARY LINE
ALBERTA CANADA
Bear Creek
North Coulee
N. Fk. Police Coulee
LEGEND
Private Irrigation
TOOLE COUNTY
BINGHAM DAM & DITCH
Police Coulee
MERIDIAN
OLD DITCHES & DAM (NOT IN USE)
W. Fk. Police Coulee
Prey Coulee
GUIDE
OLD DITCH
BINGHAM DITCH
OLD DITCH (NOT IN USE)
Dohrs Coulee
Beer Coulee
Long Coulee
Creek
BROWN PUMP-DITCHES & SPRINKLERS
BROWN DAMS & DITCHES
Larson Coulee
Brown Reservoir
Halfbreed Creek
OLD PRICE DITCH (NOT IN USE)
SCHAFER DAMS & DITCHES
BEAR CREEK SCHOOL
BUTTES
MORRISON DAMS & DITCHES
PARSELL'S DITCH & SPRINKLERS
Demarest Reservoir
Dohrs Creek
Parsell's Res.
MONTANA POWER GAS PLANT
DOLEZAL DITCHES & DAM
DOLEZAL DITCHES-PUMPS & SPRINKLERS
THREE
STRATTON DITCHES
Dohrs Creek
T. 37 N-R. 3 E
T. 36 N-R. 3 E
NINTH
STANDARD
PARALLEL
NORTH
Halfbreed Creek
Keller Creek
Leech Coulee
OLD DITCH (NOT IN USE)
Bell Creek
Bear Creek
STRODE DITCH
Bengore Creek
HALEY DITCH
Twp. 37 North
Rge. 4 East



Twp. 37 North
Rge. 5 East


ALBERTA CANADA
INTERNATIONAL BOUNDARY LINE
Corvers Coulee
Lost Coulee
Kinreed Coulee
LYBECK DAM & DITCH
Cool Coulee
Lost Coulee
Carvers Coulee
Simmingook Coulee
TURNER DAMS-DITCHES & DIKE
OLD DITCH (NOT IN USE)
Loird Creek
Laird Creek
LAIRD SCHOOL
OLD DITCH (NOT IN USE)
OLD DITCH (NOT IN USE)
SAGE CREEK COLONY PUMPS & SPRINKLERS
SAGE CREEK COLONY
Soge Creek
Moc Coulee
T. 37 N-R. 5 E
T. 36 N-R. 5 E
NINTH STANDARD PARALLEL NORTH
Chicken Coulee
Soge Creek
BONO DITCH
SAGE CREEK COLONY DITCHES
LEGEND
Private Irrigation
Twp. 37 North
Rge. 6 East



LEGEND

Privote Irrigotion

HILL

COUNTY

Twp. 37 North

Rge. 7 East